DOCUMENT RESUME

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TITLE Military Curricula for Vocational & Technical Education. Orthopedic Specialist, Classroom Course 10-13.

INSTITUTION Brooke Army Medical Center, Fort Sam Houston, Tex. Health Care Research Div.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.

PUB DATE Sep 75

NOTE 428p.; An accompanying text for this course, Orthopedic Nursing Procedures, is available on loan from The National Center Clearinghouse, The National Center for Research in Vocational Education, The Ohio State University, 1960 Kenny Rd., Columbus, OH 43210.

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DESCRIPTORS Adult Education; *Anatomy; Behavioral Objectives; Educational Objectives; Grade 11; *Health Occupations; High Schools; *Human Body; Instructional Materials; *Job Skills; Learning Activities; *Medical Services; Postsecondary Education; Skills; *Technical Education; Tests; Vocational Education

IDENTIFIERS Military Curriculum Project; *Orthopedics

ABSTRACT

These military-developed curriculum materials for a course for orthopedic specialists are targeted for students from grades 11 through the adult level. The course is designed to provide a working knowledge of the application of casts, traction, and splints to orthopedic patients and the removal of these devices; a working knowledge of assisting in minor surgical procedures; and a general knowledge of human anatomy and basic orthopedic principles. The course consists of nine academic subject areas covering 183 hours of instruction. The course package consists of a list of instructional objectives, description of the scope of subjects covered in the course, instructional guides, two technical manuals, demonstrations, and sample examinations. Subjects covered in the manuals are anatomy and physiology, care and handling of orthopedic patients, medical terminology, orthopedic conditions, methods and materials used for orthopedic appliances, supply procedures, patient relationship, and practical aspects of clinical management and application of orthopedic appliances. Demonstrations deal with the application of various types of casts and bandages. A text, Orthopedic Nursing Procedures, is to be used in conjunction with this course--see note. (MN)

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This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

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- Operating information systems and services
- Conducting leadership development and training programs

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Military Curriculum Materials
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The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1770 University Ave.
Honolulu, HI 96822
808/948-7834

ORTHOPEDIC SPECIALIST

304-91H20

Classroom Course 10-13

Developed by:

U.S. Army

Development and Review Dates:

September 1975

Occupational Area:

Health

Target Audiences:

Grade 11 - Adult

Print Pages: 418

Microfiche: 7

Availability:

Vocational Curriculum Coordination Centers

Contents:	Type of Materials: Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Instructional Design: Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Type of Instruction: Group Instruction:	Individualized:
Annex A - Anatomy and Physiology	●[1]				●		●	●		x	●	
Annex B - Care and Handling of Orthopedic Patients	●				●		●	●		x	●	
Annex C - Medical Terminology	●				●		●	●		x	●	
Annex D - Orthopedic Conditions	●				●		●	●		x	●	
Annex E - Methods and Materials Used for Orthopedic Appliances	●				●		●	●		x	●	

[1] Primarily plan of instruction only

X Materials are recommended but not provided.

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OSU
The Ohio State University

1960 Kenny Road
Columbus, Ohio 432
(614) 486-3655

Course Description:

This course is designed to provide a working knowledge of the application of casts, traction, and splints to orthopedic patients and the removal of these devices; a working knowledge of assisting in minor surgical procedures; and a general knowledge of human anatomy and basic orthopedic principles. The course consists of nine academic subject areas covering 183 hours of instruction.

Annex A - Anatomy and Physiology contains 16 lessons requiring 66 hours of instruction.
    General Osteology (1 lesson, 12 hours)
    General Arthrology (1 lesson, 6 hours)
    Skeleton (3 lessons, 21 hours)
    Muscle, Nervous, and Skin Systems (6 lessons, 23 hours)
    Other Body Systems (5 lessons, 5 hours)
Annex B - Care and Handling of Orthopedic Patients has 8 lessons covering 25 hours of instruction.
    Proper Handling of Patients with Various Medical Conditions (3 lessons, 10 hours)
    Proper Handling of Patients Confined to or Requiring Equipment (2 lessons, 12 hours)
    Handling Patients with Wounds (2 lessons, 5 hours)
Annex C - Medical Terminology consists of 2 lessons requiring 3 hours.
    Orthopedic Terms (2 hours)
    Prefixes, Suffixes and Stems of Medical Terms (1 hour)
Annex D - Orthopedic Conditions contains 5 lessons covering 32 hours of instruction.
    Fractures, Sprains and Dislocations (12 hours)
    Congenital Deformities (8 hours)
    Neuromuscular Diseases (4 hours)
    Infections and Diseases (4 hours)
    Nutritional and Metabolic Conditions (4 hours)
Annex E - Materials and Methods has 10 lessons covering 57 hours of instruction.
    Padding Cast (2 lessons, 7 hours)
    Plaster Cast (2 lessons, 21 hours)
    Cast Removal (2 lessons, 13 hours)
    Traction (2 lessons, 13 hours)
    Miscellaneous Materials (2 lessons, 3 hours)

Each annex has a purpose stated and listing of scope of lesson and appropriate references. The student tests are illustrated and cover all of the course materials. The course is designed for group instruction.

ORTHOPAEDIC SPECIALIST

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DRAFT

BROOKE GENERAL HOSPITAL
BROOKE ARMY MEDICAL CENTER
FORT SAM HOUSTON, TEXAS

September 1975

PROGRAM OF INSTRUCTION

FOR

304-91H20

ORTHOPAEDIC SPECIALIST COURSE

MOS: 91H20

Length: Peacetime - 12 weeks
Mobilization - none

Approved by:

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SECTION I - PREFACE

A. Course: 304-91H20, Orthopaedic Specialist.

B. Purpose: To provide a working knowledge of the application of casts, traction, and splints to orthopaedic patients and the removal of these devices; a working knowledge of assisting in minor surgical procedures; and a general knowledge of human anatomy and basic orthopaedic principles. MOS for which trained: Orthopaedic Specialist (91H20).

C. Instructional Objectives:

1. Relate basic anatomy (especially of the bones, major vessels, nerves, and muscles) as to location and position in the treatment of orthopaedic conditions.
2. Familiarize with orthopaedic conditions, types, and nomenclature of fractures, dislocations, sprains, congenital deformities and diseases relating to orthopaedic conditions.
3. Familiarize with the physiological and anatomical structure of other body systems (e.g. circulatory, respiratory, digestive, endocrine and gastrourinary.)
4. Observing the principles of asepsis, perform dressing changes, sterile scrubs and suture removal.
5. Perform prep for patients going for major orthopaedic surgical procedures.
6. Assist the physician in minor surgical procedures.
7. Observing accepted principles involved in the use of traction, set up specific types of traction quickly and correctly; assist the doctor in setting up and adjusting special traction for specific patient needs.
8. Operate and adjust fracture table.
9. Fabricate and apply properly plaster casts, modifying them as required.
10. Apply casts and splints used in surgery.
11. Giving proper instruction to patients (e.g. care of casts and splints, proper crutch walking techniques and precautions to be observed.)

ORTHOPAEDIC SPECIALIST COURSE

Peacetime: 12 weeks--(528 Hours)

Mobilization: None

Subject	Hours and Type		Annex	Page
	Peace	Mob		
A. Academic Subjects:				
Anatomy and Physiology	66	0	A	7-10
Care and Handling of Orthopedic Patients	25	0	B	11-12
Medical Terminology	3	0	C	13
Orthopedic Conditions	32	0	D	14-15
Methods and Materials used for Orthopedic Appliances	57	0	E	16-17
Supply Procedures	4	0	F	18
Office Procedures	6	0	G	19
Patient Relationship	2	0	H	20
Practical Aspects of Clinical Management and Application of Orthopedic Appliances	235	0	I	21
Examination, Reteaching Sessions, and Library Research	44	0	J	22
Subtotal	474	0		

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Subject	Scope	Hours and Type		Annex	Page
		Peace	Mob		
Anatomy and Physiology	General Osteology (12-0). General Arthrology (6-0). Axial Skeletal (6-0). Appendicular Skeleton--Upper Extremities (7-0). Appendicular Skeleton--Lower Extremities (7-0). General Myology (5-0). Nervous System (5-0). Palpation points of lower and upper Extremities (4-0). Bony Landmarks (4-0). Planes and Positions (4-0). Skin and Connective Tissue (1-0) Respiratory System (1-0). Circulatory System (1-0). Digestive System (1-0). Genito-urinary System (1-0). Endocrine System (1-0).	66	0	A	
Care and Handling of Orthopaedic Patients	Proper Handling of Patients with Fractures, Sprains, and Dislocations (6-0). Proper Handling of Patients with Paraplegic Conditions (2-0). Proper Handling of Patient with Congenital Conditions (2-0). Proper Care and Handling of Patients Placed on Beds, Litters, Wheelchairs, and Frames (4-0). Proper Care and Handling of Patients in Casts, Splints, and Traction (6-0). Proper Care and Handling of Patients with Wounds, Skin Grafts, and Surgical Procedures (3-0). Proper Asepsis in Treatment of Patients (2-0).	25	0	B	
Medical Terminology	Orthopaedic Terms (2-0). Prefixes, Suffixes, and Stems of Medical Terms (1-0).	3	0	C	
Orthopaedic Conditions	Fractures, Sprains, and Dislocations (12-0). Congenital Deformities (8-0). Neuromuscular Diseases (4-0). Infections and	32	0	D	

Subject	Scope	Hours and Type Peace	Mob	Annex	Page
	Diseases (4-0). Nutritional and Metabolic Conditions (4-0).				
Methods and Material used for Orthopaedic Appliances	Materials used for Padding Cysts (1-0). Techniques of Application of Padding Material (6-0). Plaster Materials Used in Casting (1-0). Plaster Techniques used in Casting (20-0). Materials used in Removal of Casts (12-0). Material used for Traction (1-0). Techniques of Traction (12-0). Miscellaneous Material (1-0). Application Techniques for Miscellaneous Material (2-0).	57	0	E	
Supply Procedures	Evaluation of Supply Needs and Using Cataloges to Obtain Data (1-0). Requesting and Turning-in of Standard Supplies and Equipment (2-0). Maintenance of Hand Receipt and Ordering Non-standard Supplies (1-0).	4	0	F	
Office Procedures	Routine Procedures (2-0). Set-up and Maintenance of Appointment Systems (2-0). Maintaining Records and Submitting Feeder Reports (2-0).	6	0	G	
Patient Relationship	Communications (1-0). Relationships with Irrational Patients (1-0).	2	0	H	
Practical Aspects of Clinical Management and Application of Orthopaedic Appliances	Practical Experience (235-0).	235	0	I	
Examinations, Reteachings, and Library Research	Written and Practical Examinations (18-0). Reteaching Sessions (18-0). Library Research (8-0).	44	0	J	

SECTION IV - ANNEX

ANNEX A

Peacetime: 66 Hours

Mobilization: 0

PURPOSE: To provide the student with introductory knowledge of general anatomy and physiology, to include skeletal, muscular, nervous, organ, connective tissue functions thereof.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
General Osteology	U	2L 4C 6D	0	Presentation of the types of bones, as to structure and composition. General organization and function of the skeletal system.*	TM 8-230 chap. 2, sect. III, para 2-10 thru 2-12 TM 8-231 chap 2, sect I thru para 4-7 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 35 thru 40
General Arthrology	U	2L 2C 2D	0	A study of the description and general structure of joints, types of joints, and classification of joints.*	TM 8-230 Appendix B TM 8-231 chap 2, para 8-23, and fig 28, p.34 Handbook of Anatomy and Physiology for Student X-ray Technicians chap 1, sect 5, chap 6, 7, & 8, sect 43-65
Axial Skeleton	U	2L 2C 2D	0	A study of the bones and associated joints of the spinal column, and relationship of the skull and thorax as they apply to orthopaedics.*	TM 8-230 chap 2 para 2-14 thru 2-16 TM 8-231 chap 2 para 9 thru 11 Handbook of Anatomy and Physiology for Student X-ray Technicians chap 8, 9, 10 sec. 61

*X-ray film, slides, and/or film may be used for demonstration.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Appendicular Skeleton-upper extremities	U	2L 2C 3D	0	A study of the bones and associated joints of the shoulder, girdle, upper arm forearm, and hand.*	TM 8-230 chap 2 para 2-14 thru 2-16 TM 8-231 chap 12 para 12-17 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 43-47
Appendicular Skeleton-lower extremities	U	2L 2C 3D	0	A study of the bones and associated joints of the pelvic girdle, hip, thigh, leg, and foot.*	TM 8-230 chap 2 para 2-18 TM 8-231 chap 18 para 18-23 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 52-56
General Myology	U	1L 2C 2D	0	A study of the types of muscle, the structure, location and action of the various types. The arrangement and nomenclature of skeletal muscles.*	TM 8-230 chap 2 para 2-22 thru 2-26 TM 8-231 chap 30 para 30-37 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 98-103 Kranz Manual of Kinesiology (entire ref.)
Nervous System	U	1L 2C 2D	0	A Study of the organization structure, and function of the nervous system, especially as related to muscle and bone. Survey of the peripheral nerves found in relation to bone.*	TM 8-230 chap 2 para 2-70 thru 2-73 TM 8-231 chap 24 para 24-29 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 168-173
Palpation Points of Upper and Lower Extremities	U	1L 1C 2D	0	A study of palpation points of upper and lower extremities as they relate to orthopaedic appliances.*	(entire ref.)

*X-ray film, slides, and/or film may be used for demonstration.

Subject and LP No	Classification	Hours and Type Peace	 Mob	Scope	References
Bony Landmarks	U	1L 1C 2D	0	A study of bony landmarks as they relate to orthopaedic appliances.*	Handbook of Anatomy and Physiology for Student X-ray Technicians sect 49, 58, 6 Kranz Manual of Kinesiology (entire ref.)
Planes and Positions	U	1L 1C 2D	0	A study of planes and positions and their relation to fitting orthopedic appliances.*	TM 8-230 chap 2 para 2-8 TM 8-230 chap 2, 7-14 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 3-7 Kerr Orthopedic Nursing Procedures, selected references
Skin and Connective Tissue	U	1L	0	A study of epithelium, the structure and related function of the skin and skin appendages. Types of connective tissue structure as related to orthopedics.*	TM 8-230 chap 2 para 2-46 thru 2-49 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 126-130
Respiratory System	U	1L	0	A study of the organs of respiration including lungs, airway muscles, and mechanics of respiration as related to orthopedics.*	TM 8-230 chap 2 para 2-46-2-49 Handbook of Anatomy and Physiology for Student X-ray Technicians sect 126-130

*X-ray film, slides, and/or film may be used for demonstration.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Circulatory System	U	1L	0	A study of the relation, structure and function of the heart and blood vessels on the peripheral vessels as related to orthopedics.*	TM 8-230 chap para 2-31 thru 2-45 TM 8-231 chap 38 para 38-41 Handbook of Anatomy and Physiology for Student X-ray Technician sect 112-115
Digestive System	U	1L	0	A study of the relations, structure and function of the various parts of the digestive tube as related to orthopedics*	TM 8-230 chap 2 para 2-50 thru 2-61 Handbook of Anatomy and Physiology for Studen X-ray Technician sect 133-139.-
Genito-Urinary System	U	1L	0	A study of the urinary and reproductive organs as related to orthopaedics.*	TM 8-230 chap 2 para 2-62-2-68 and 2-82 Handbook of Anatomy and Physiology for Student X-ray Technicans sect 145-162
Endocrine System	U	1L	0	A study of the endocrine gland as related to orthopedics.*	TM 8-230 chap 2 para 2-77-2-83 Handbook of Anatomy and Physiology for Student X-ray Technician sect 163-167

*X-ray film, slides, and/or film may be used for demonstration.

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SECTION IV - ANNEX A (Cont)

BIBLIOGRAPHY

Mallet, M. M. D. A Handbook of Anatomy and Physiology for Student X-ray Technicians Edwards Brothers, Inc. Ann Arbor, Michigan 1960.

Larson and Gould Calderwood's Orthopedic Nursing The C. V. Mosby Company St. Louis, Missouri 1960.

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New York, N. Y. 1969.

SECTION IV - ANNEXES

ANNEX B

CARE AND HANDLING OF ORTHOPAEDIC PATIENTS

Peacetime: 25 Hours
Mobilization: 0

PURPOSE: To provide the student with an introductory knowledge of the various orthopedic patients' problems requiring special care and consideration.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Proper Handling of Orthopedic Patients with Fractures, Sprains, and Dislocations	U	1L 2C 3D	0	A study of technique used to splint, case, place in traction and move patients with fractures, sprains, and dislocations.*	TM 8-230 chap 5 para 5-114 thru 5-132, chap 8 para 8-24 thru 8-32 TM 8-231 chap 7-14 Kerr Orthopedic Nursing Procedures, p. 65-338 Calderwood's Orthopedic Nursing chap 2
Proper Handling of Patients with Paraplegic Conditions	U	1L 1D	0	A study of paraplegic conditions and techniques used to treat and move patients who are paraplegic.*	TM 8-230 Chap 5 para 5-129 thru 5-132 TM 8-231 chap 3 para 54 & chap 3 Kerr Orthopedic Nursing Procedures p. 89-127 Calderwood's Orthopedic Nursing chap 8-9 Local SOP's
Proper Handling of Patients with Congenital Conditions.	U	1L 1D	0	A study of techniques used in treatment and movement of patients with congenital conditions.*	TM 8-230 chap 10 para 10-58 & 10-61 TM 8-231 chap 3 para 55 & 56 Local SOP's
Proper Care and Handling of Patients Placed on Beds, Litters, Wheelchairs, and Frames	U	1L 1C 2D	0	A study of techniques used to care for and move patient on and off beds, litters, wheelchairs, and frames.*	TM 8-230 chap 5 para 5-118, 5-123-5126 &5-12 thru 5-131 TM 8-231 chap 14 Kerr Orthopedic Nursing Procedures p. 9-38 & selected ref. p. 89-319

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Proper Care and Handling of Patients Placed in Casts, Splints, and Traction	U	1L 1C 4D	0	A study of techniques used to properly handle and care for patients who are placed in casts, splints, and traction.*	TM 8-230 chap 5 para 5-114 thru 5-131 TM 8-231 chap 7-14 Kerr Orthopedic Nursing Procedures (entire publication) Calderwood's Orthopedic Nursing chap 2 Local SOP's
Proper Care and Handling of Patients with Wounds, Skin Grafts, and Surgical Procedures	U	1L 2D	0	A study of techniques used in the pre-operative and post-operative care of patients.*	TM 8-230 chap 5 para 5-102 thru 5-111 TM 8-231 chap & appendix II Kerr Orthopedic Nursing Procedures p. 265-325 Local SOP's
Proper Asepsis in Treatment of Patients.	U	1L 1D	0	A study of techniques of asepsis used in treatment of patients with wounds, surgery procedures, or isolation.*	TM 8-230 chap 5 para 5-92 thru 5-99 & chap. 6 para 6-31-6-36 TM 8-231 chap Local SOP's

*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEX B (Cont)

BIBLIOGRAPHY

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New York, N. Y. 1969.

Larson and Gould Calderwood's Orthopedic Nursing The C. V. Mosby Company St. Louis, Missouri 1960.

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SECTION IV - ANNEXES

ANNEX C

MEDICAL TERMINOLOGY

Peacetime: 3 Hours
Mobilization: 0

PURPOSE: To provide the student with a working knowledge of the special vocabulary used in orthopedics and medical terminology.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Orthopedic Terms	U	2L	0	Definition and explanations of medical terms used in orthopedic conditions.*	TM 8-231 chap 3. Kerr Orthopedic Nursing Procedures p. 45-62 Local Terminology
Prefixes, Suffixes and Stems of Medical Terms	U	1L	0	Definition and explanations of prefixes, suffixes, and stems, to give key to medical terminology.*	TM 8-230 chap 2 para 2-8 & 2-9 Kerr Orthopedic Nursing Procedures p. 411-414 Handbook of Anatomy and Physiology for Student X-ray Technician sect 2-7. Local Terminology

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*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEX C (Cont)

BIBLIOGRAPHY

Mallett, M. M. D. A Handbook of Anatomy and Physiology for Student X-ray Technicians Edwards Brothers, Inc. Ann Arbor, Michigan 1960.

Larson and Gould Calderwood's Orthopedic Nursing The C. V. Mosby Company St. Louis, Missouri 1960

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New York, N. Y. 1969.

SECTION IV - ANNEXES

ANNEX D

ORTHOPEDIC CONDITIONS

Peacetime: 32 Hours
Mobilization: 0

PURPOSE: To provide the student with an introductory knowledge of various conditions to include physical, congenital, infectious, nutritional and metabolic causes of orthopedic disability and treatment thereof.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Fractures, Sprains, and Dislocations	U	2L 2C 8D	0	Descriptions and explanations of open, closed, and comminuted fractures; open and closed dislocations; sprains and strains of ligaments and muscles; and techniques used in treatment of these traumatic conditions.*	TM 8-230 chap 3 para 3-3 chap 8 para 8-24-8-32 TM 21-11 chap 3 sect II Kerr Orthopedic Nursing Procedures p. 59-94 Local SOP's
Congenital Deformities	U	1L 2C 5D	0	Description and explanation of congenital deformities such as congenital dislocated hip, club foot, torticolis, elevation of scapula, spina bifida, syndactylism, and absence of bones in children.*	TM 8-231 chap 3 para 55 & 56 Local SOP's
Neuromuscular Diseases	U	1L 1C 2D	0	Description and explanation of paralysis, muscular atrophies, and dystrophies.*	TM 8-231 chap 3 para 54 Kerr Orthopedic Nursing Procedures, p. 95-100 Local SOP's
Infections and Diseases	U	1L 1C 2D	0	Description and explanation of septic reumatoid hypertrophic arthritis, tuberculosis, spinal curvature, slipped femoral epiphysis, osteochondritis to include leg perther, scheuermann or affected joints.*	
Nutritional and Metabolic Conditions	U	1L 1C 2D	0	Description and explanation of scurvy, rickets, hyperpararathyroidism, padge's disease, certain spastic conditions and the effect of vitamin deficiency on body parts.*	TM 8-231 chap 3 para 44 TM 8-500 chaps 2 & 4 Local SOP's

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*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEX D (Cont)

BIBLIOGRAPHY

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New York, N. Y. 1969

Larson and Gould Calderwood's Orthopedic Nursing The C. V. Mosby Company St. Louis, Missouri 1960.

SECTION IV - ANNEXES

ANNEX E

Peacetime: 57 Hours
Mobilization: 0

PURPOSE: To provide the student a general knowledge of material and appliances used in the treatment of ortheopedic conditions, with an introduction of practical experience in the application and removal thereof.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Materials Used for Padding Cast	U	1L	0	To make the student familiar with the nomenclature and use of protective padding material.*	TM 8-231 chap 8, para 105 & 106 Manufacturer's Justification Local SOP's
Technique of Application of Padding	U	2D 4PE	0	To provide a working knowledge of the application of padding material, with demonstration by instructors and practical experience application by the student.*	(Previous reference)
Plaster Material used in Casting	U	1L	0	To make the student familiar with the nomenclature and use of plaster materials.*	TM 8-231 chap 8 para 103 & 104 Manufacturer's Specifications Local SOP's
Plaster Techniques used in Casting	U	4D 16PE	0	To provide the student with a working knowledge of the application of plaster materials with demonstration by instructors and practical experience application by the student.*	TM 8-231 chap 9 para 112-121 chap 10-12 Kerr Orthopedic Nursing Procedures p.151-159 Local SOP's
Materials used in Removal of Casts	U	1L	0	Make familiar with the nomenclature and use of equipment used in the removal of casts.	TM 8-231 chap 8 para 107 & 108 Manufacturer's specifications Local SOP's
Techniques used in the Removal of Casts	U	2D 10PE	0	To provide the student with a working knowledge and feel of equipment, with demonstration by instructors and practical experience of removal by the student.*	TM 8-231 chap 9 para 122, 124-8 Kerr Orthopedic Nursing Procedures p. 162-3 Local SOP's

*X-ray film, slides, and/or film may be used for demonstration.

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Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Materials used for Traction	U	1L	0	To familiarize the student with the nomenclature and use of traction material.*	TM 8-231 chap 13 Kerr Orthopedic Nursing Procedures p. 187-263 Local SOP's
Techniques of Traction	U	2D 10PE	0	To provide the student with a working knowledge of the application and removal of traction equipment with demonstration by instructors and practical experience of application and removal by the student.*	(Previous reference)
Miscellaneous Material	U	1L	0	To familiarize the student with the nomenclature and use of miscellaneous material such as clavicular harness, cervical collar, figure-of-eight, pneumatic splint, and other commercial products.*	Manufacturer's Specifications Local SOP's
Application Techniques for Miscellaneous Material	U	1D 1PE	0	To provide the student with a working knowledge of the application of miscellaneous material, with demonstration by instructors and practical experience application by the student.*	(Previous references)

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*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEX E (Cont)

BIBLIOGRAPHY

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New Yrok, N. Y. 1969.

ANNEX F
SUPPLY PROCEDURES

Peacetime: 4 Hours
Mobilization: 0

PURPOSE: To provide the student with an introductory knowlodge of evaluating, requesting, turn-in, and maintenance of supplies.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Evaluation of Supply Needs and Using Catalogues to Obtain Data	U	1C	0	To familiarize the student with the need of evaluating supplies, and how to obtain data from catalogues.*	Medical Material Section Federal Supply Catalogue Commercial Catalogues Local SOP's
Requesting and Turning-in of Standard Supplies and Equipment	U	1C	0	To familiarize the student with the use of AR's to obtain data and procedures to be used in preparing DA 2765 and 2765-1.*	AR 710-2 chap 2, sect II & III figure 2-14 & 2-15
Maintenance of Hand Receipt and Ordering Non-standard Supplies	U	1C	0	To familiarize the student with the use of AR's to obtain data in maintaining hand receipt DA Form 2062 and local policy in ordering non-standard and supplies. *	AR 710-2 chap 2, sect II Local hospital supply SOP

*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEXES

ANNEX G

OFFICE PROCEDURES

Peacetime: 6 Hours
Mobilization: 0

PURPOSE: To provide the student with an introductory working knowledge of maintaining an office and carrying out routine administrative duties.

Subject and LP No	Classification	Hours and Type Peace	 Mob	Scope	References
Routine Procedures	U	1C 1PE	0	To familiarize the student with answering of telephone, routine correspondence, health records, routine filing and where to direct request for support to accomplish mission.*	AR 40-2 C9 sect IX & XI AR 40-4 AR 340-15 Local SOP's
Setting-up and Maintenance of Appointment System	U	1C	0	To familiarize with appointment book, and appointment slips and the priority to be given patients.*	Local SOP
Maintaining Records and Submitting Feeder Reports	U	1C 1PE	0	To familiarize the student with proper maintenance of records and procedure in submitting feed reports.*	AR 40-419 AR 340-18-1 AR 340-18-9 Local SOP

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*X-ray film, slides, and/or film may be used for demonstration.

ANNEX H

PATIENT RELATIONSHIP

Peacetime: 2 Hours
Mobilization: 0

PURPOSE: To provide the student with an introductory knowledge of proper communications with staff and patient and proper procedures to be used in dealing with patients having irrational behavior.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Communications	U	1C	0	To make student aware of procedures to be used in dealing with staff and patients.*	Local SOP's selected references
Relationship with Irrational Patients	U	1C	0	To provide the student with methods that may be used in meeting the needs of a patient with an irrational behavior problem.*	Kerr Orthopedic Nursing Procedures p. 2 & 3 p. 371-373

***X-ray film, slides, and/or film may be used for demonstration.**

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BIBLIOGRAPHY

Kerr, Avice R. N. B. A. Orthopedic Nursing Procedures Springer Publishing Company, Inc. New York, N. Y. 1969

Larson and Gould Calderwood's Orthopedic Nursing The C. V. Mosby Company St. Louis, Missouri 1960.

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SECTION IV - ANNEXES

ANNEX J

EXAMINATION, RETEACHING SESSIONS, AND LIBRARY RESEARCH

Peacetime: 44 Hours
Mobilization: 0

PURPOSE: To measure the level of achievement of course objectives attained by the student in the orthopedic specialist course and provide time for individual research.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Written and Practical Examinations	U	18E	0	Written and practical evaluation of the student's achievement.*	All previous references listed
Reteaching Sessions	U	18C	0	Discussion and correction of any errors or omissions in student as demonstrated in the examinations--one hour per each hour of examination.*	All previous references listed
Library Research	U	8SS	0	Students may use library facilities in their self-study and research in orthopedic medicine throughout the course.*	

*X-ray film, slides, and/or film may be used for demonstration.

SECTION IV - ANNEXES

ANNEX I

PRACTICAL ASPECTS OF CLINICAL MANAGEMENT AND APPLICATION OF ORTHOPEDIC APPLIANCES

Peacetime: 235 Hours
Mobilization: 0

PURPOSE: To provide the student with a basic practical experience in the management and treatment of patient with orthopedic conditions.

Subject and LP No	Classification	Hours and Type Peace	Mob	Scope	References
Practical Experience	U	235PE	0	To give the student a basic skill in the application of all orthopedic appliances and a working knowledge of the management and treatment of all orthopedic conditions.*	All previous references listed

*X-ray film, slides, and/or film may be used for demonstration.

anxiety to the patient. Encourage the family member to ask the doctor about the patient's condition and the proposed surgery.

PHYSICAL PREPARATION

Routine preoperative physical preparation is organized in accordance with locally prepared standing operative procedures (SOP) to avoid last minute delay, confusion, or omission of an essential detail. Specific preoperative orders for each individual patient are always written by the surgeon and the anesthesiologist; these orders always modify any routine SOP. The time required to prepare the patient varies with each case. The patient may be admitted the day before surgery, several days in advance, or only a few hours before emergency surgery. However, for purposes of this manual, the immediate preoperative preparation is discussed in two parts: the day before and the day of surgery.

Day Before Surgery

All the details to be completed in order to have the patient ready for the operating room on the scheduled day and at the scheduled hour are usually listed on a preoperative checklist. In many AMEDD hospitals, a local form is used by nursing personnel. It is placed on the front of the patient's chart holder when he is scheduled for surgery. Items listed are checked off and initialed by the responsible nursing individual as they are completed. Items that do not apply to the specific patient are either ruled out or followed by the initials "N/A" (Not Applicable). Typical items on a preoperative checklist include—

1. Check of Clinical Record for—
    a. Properly filed laboratory and other diagnostic reports—*for example,* a complete blood count (CBC), urinalysis, chest X-ray, bleeding and clotting time, blood chemistries, and electrocardiogram.
    b. Preoperative medical history and physical examination record completed by the doctor.
    c. Reports and record forms prepared for use in the OR, such as the anesthesia record, operation report, and pathology (tissue examination) forms.
2. Signed authorization for surgery (SF 522, Authorization For Administration of Anesthesia and Performance of Operations and Other Procedures). This signed witnessed consent must be obtained for all nonmilitary patients. Although not mandatory for military personnel, the policy in most AMEDD hospitals is to obtain authorization for all patients. The doctor is responsible for counseling the patient and explaining the scheduled procedure in appropriate terms. The signed dated consent must then be filed in the Clinical Record.
3. Visit from chaplain.
4. Diet order. Nothing by mouth (NPO) is usually ordered after a certain hour. Cancel diet order by deleting patient's name from diet roster after evening meal, if appropriate.

NOTE

> Be sure the patient is told exactly what is permitted and up to what hour. Encourage him to force fluids up to the cutoff time and then remove his bedside water pitcher and drinking glass.

5. Skin preparation order.
6. Cleansing enema order.
7. Preoperative medication orders to include bedtime sedative the night before surgery.
8. Prosthetic appliances to be removed and safeguarded (*for example,* dentures, eye glasses, contact lenses, limbs, and wigs).
9. Valuables deposited in Treasurer's Office.
10 X-rays to accompany patient to the OR immediately available on the ward.
11. Ident-a-Band or other patient identification attached to the patient's wrist.
12 Patient instructed on night and morning procedures to be performed.

Day of Surgery

Begin preparation of the patient at least 2 or 3 hours before the scheduled hour for "on call" to the operating room. Plan activities so that they are completed before the preoperative medication is given.

1. Review preoperative doctor's orders.
2. Review preoperative checklists to make sure no preliminary routine details have been omitted.
3. Take and record TPR and BP. Report any abnormal findings immediately to the ward nurse or doctor. Report and record any sign of an upper respiratory infection—cough, sniffles, or sore throat.
4. Give morning care. If a cleansing bath has not been given the preceding evening, give bath or have patient shower if time and the patient's condition permit. Cleanse or assist

2. Once daily, take thermometer and its container to utility room.
    a. Wash container and thermometer thoroughly.
    b. Place clean cotton in bottom of container to protect tip of thermometer.
    c. Refill with fresh germicide solution and return it to unit.

NOTE

Follow local policy for terminal care of thermometer. The policy may be to discard it, with no attempt to disinfect for return to common use.

5-100. Visitors for a Patient in Isolation

Visitors must receive instructions and be carefully and courteously reminded to follow instructions. In some instances visitors (including noninvolved duty personnel) must be excluded; in others, they may be admitted on a restricted basis and in accordance with hospital regulations. Noninstructed individuals cannot be expected to understand the sign "Isolation" at the entrance to the unit; therefore, a more helpful practice is to add an additional sign such as "Visitors—Please Report To Nurses' Station For Instructions Before Entering This Room." The nurse in charge or senior NCO is then responsible for assisting and observing them. It is important to provide a coat rack or similar facility for such things as overcoats which should not be worn when entering the isolation unit.

5-101. Reverse Isolation

Reverse isolation is a protective measure ordered by a medical officer to protect the patient from contact with pathogenic organisms in the environment. It is an important part of the medical management of a patient with extensive burns or with other conditions in which the patient has a diminished ability to fight infection with his own protective body defenses. By isolating the patient and by carrying out meticulous medical and surgical aseptic techniques while providing all therapeutic and supportive measures, the patient is assured of a margin of safety in the prevention and control of infection.

a. Routine Reverse Isolation. For a patient requiring conventional protective measures, placing the patient in a thoroughly clean room, introducing only aseptic equipment and supplies and observing meticulous handwashing, gowning, and masking techniques before entering the room or caring for him may be sufficient. The door to the room is kept closed. Ventilation within the room is usually controlled by an air conditioner equipped with an air filter.

b. Use of the RES-SYSTEM. The RES-SYSTEM (Regulated Environment for Safety System) is an application of reverse isolation using a self-contained plastic isolator. The patient is encapsulated within a plastic inclosure, and care is accomplished through closed plastic sleeves. (For guidance information in the use of the patient isolator, see TB MED 275.

5-102. Preoperative Patient Care

The aim of preoperative preparation is to have the patient in the best possible mental and physical condition. The success of an operative procedure depends to a large extent upon this preoperative preparation, which begins with the admission of the patient. It is important to emphasize that any surgery, regardless of whether it is recorded as a major or a minor operation, is a major procedure for the patient, so he must be prepared both mentally and physically.

MENTAL PREPARATION

Although not ordered in writing, mental preparation is just as important as physical preparation. All persons coming into contact with the patient contribute to this mental preparation. However, as nursing personnel, you can provide major assistance since you are with the patient for longer periods of time.

1. Make every approach to the patient an opportunity to show that he is an individual.
2. Keep him informed. Often many routine procedures and special orders must be carried out, and the patient can become increasingly anxious from not knowing what to expect next. Although technical information is given only by the doctor, appropriate explanations are necessary to insure understanding and cooperation.
3. Perform all procedures in a quiet, thorough, systematic manner. This is a far more effective way to inspire confidence then merely to state that "everything is going to be all right." The patient must feel that he can place himself completely in the hands of competent individuals.
4. Remember that the patient's visiting family members need reassurance and information. A worried, poorly informed relative can transmit

CONCURRENT CLEANING IN THE ISOLATION UNIT

1. Wear gown and mask.
2. Damp-dust all furniture and equipment surfaces within the unit daily. Use a basin of prescribed germicide and a cleaning cloth. Rinse the cloth frequently. After use, discard the cloth in the waste receptacle.
3. Dispose of cleaning solution in flush-hopper or toilet. Wash and sanitize the basin.
4. Ventilate the unit with fresh air and expose it to sunlight as much as possible. Keep door closed.
5. If responsible for floor care, use a damp mop only and prescribed germicide solution in the mop bucket. Discard solution in hopper or toilet. Discard mop head, after one-time use, in laundry bag. Scrub and rinse the mop bucket, wringer, and mop handle with clean germicide solution and airdry before returning this equipment to the cleaning closet.

NOTE

Never use floor-cleaning equipment interchangeably from isolation unit to clean areas. Although all floors are considered contaminated, this precaution reduces the spread of a known concentration of pathogenic organisms.

TERMINAL CLEANING OF THE ISOLATION UNIT

In most instances, ordinary measures as described in paragraph 5–7, are all that are necessary. Air unit for 8–24 hours, depending upon local policy, before making bed. Follow local policy for terminal disinfection of mattress and pillows when they are sent to laundry for autoclaving.

5–99. Taking TPR of Patient in Isolation

The patient in isolation has an individual thermometer setup at his bedside. The following procedure is an acceptable method of taking and recording the TPR and caring for the thermometer of a patient in isolation.

PROCEDURE

1. Before entering the unit, obtain a pencil and a paper cup containing two or three gauze squares moistened in water.
2. Place wristwatch, pencil, and cup on clean table at entrance.
3. Open one paper towel and leave it on the table.
4. Put on gown and mask.
5. Enter unit carrying paper cup, pencil, two folded paper towels, and watch in one hand.
6. With free hand, place one paper towel on bedside table with edge of towel extending beyond the edge of the table. Place watch on this towel (top side of towel and watch remain clean).
7. Place second towel, pencil, and cup on table.
8. Remove thermometer from holder containing germicide. Using water-moistened squares, wipe thermometer to remove germicide. Read and shake down thermometer.
9. Place thermometer in patient's mouth (or if rectal, lubricate and insert in rectum).
10. If necessary to hold watch while counting pulse and respiration, slide the paper towel with the watch onto your hand by reaching under the extended edge of the towel. When finished, slide paper towel with watch back on table, protecting top clean surface of towel and the watch.
11. Record TPR on second paper towel, using the pencil.
12. After removing thermometer, wipe with tissue from patient's supply. Read thermometer; discard tissue in bag.
13. Take three germicide saturated sponges from container at bedside and wipe thermometer three times, using rotary motion from stem to bulb end. Discard wipes. Return mechanically cleansed thermometer to holder.
14. Discard paper cup in waste bag.
15. Carry paper towel with watch and paper towel on which TPR is recorded from unit. Slide watch on to clean table surface and discard this towel. Place towel on which TPR is recorded on clean open towel.
16. Wash hands; remove gown and mask.
17. With clean hands, record TPR on TPR work sheet. Discard towel.

NOTE

Recording at the bedside for transscription in a clean area is recommended for accuracy; if there are any interruptions, there is less chance of forgetting the TPR reading. The pencil can be left at the bedside and replaced p.r.n.

Care of Individual Thermometer Setup

1. Keep thermometer container filled with prescribed germicide and the container of wipes replenished.

leather and other porous items.	firm, twisting, friction movement on all surface, working from the top, down. 4. Follow with fresh alcohol wipe. 5. Air dry. 6. Return to common-use storage area. 7. For large, nonimmersible items with porous cover, wipe surface with moistened cloth. Expose to sunlight and air for 6 hours on every surface.

Table 5–7. *Ward Care of Contaminated Equipment*—Continued

a. Item	Preliminary steps b. by ward personnel	c. General instructions	Suggested cleanup or holding d. Area on ward	e. Field expedients
Food trays, etc.—Continued		dishes into bag without touching outside of bag. Assistant closes bag and places wrapped tray in designated area for pickup by food service personnel.		
Linen and all washable clothing.	Place directly into laundry bag within isolation unit.	1. Handle linen with no shaking or flapping. 2. Roll linen as removed from bed. 3. Place laundry bag from unit in open bag outside unit. Use care not to touch outside surface of this bag. 4. With clean hands, at outside of unit, close laundry bag when no more than two-thirds full by slipping hands under folded-down cuff. Tie securely. 5. Check color-coded tag "contaminated laundry" attached to outside of bag. 6. Replace clean laundry bag stat, using care to fit into conveyor with 12-inch, turn-down cuff.	Take to laundry pickup point (outside of bag is clean).	Same—laundry point pickup service by quartermaster unit.
Treatment trays and reuseable items from CMS.	Discard wastes. Unless otherwise specified, discard catheters, rubber gloves, gastrointestinal tubes, needles, knife blades, etc., into waste receptacle in patient unit. Discard linen and wrappers into laundry bag in patient's unit.	1. Request "clean" assistant to hold open a large, steam-permeable paper bag (approved for use by CMS). 2. Slide tray and contents into open bag held by "clean" assistant. 3. Request "clean" assistant to close bag and place it at designated CMS pickup point, with attached label on bag: "Isolation Unit-Contaminated."	Designated CMS pickup area. The wrapper is clean on outside for safe handling.	Same—steam processing by autoclave in CMS before any handling of contents for final processing.
Miscellaneous: treatment and diagnostic equipment retained on the ward: (Sphygmomanometers, stethoscopes, flashlights, etc.) Items not immersible in boiling water and requiring chemical disinfection; *for example,*	1. Take from patient unit to utility room. 2. Remove all connections and detachable parts. 3. Discard all catheters, etc., that have been inserted into body cavities.	1. Provide individual equipment for the patient when possible. 2. When items must be used and returned to common use, allow time for proper cleansing and do not attempt to "keep items clean" while being used in isolation unit. 3. Use gauze or cloth saturated with 70% alcohol. Wipe items with	Utility room	Same technique, field or fixed.

Table 5-7. Ward Care of Contaminated Equipment

	Preliminary steps		Suggested cleanup or holding	
a. Item	b. by ward personnel	c. General instructions	d. Area on ward	e. Field expedients
Utensils from patient's unit (Bath basins, emesis basins, trays or similar items retained on ward).	Empty all contents into toilet or hopper and flush into sewerage system.	1. Use paper towel to turn on water faucet or flush valve. 2. Rinse with cold water, avoiding splashing. 3. Clean with brush using germicide detergent or hot soap and water. Use friction. Rinse well. 4. Empty cleaning and rinse solution into toilet or hopper. 5. Place cleansed utensils in boiling water sanitizer. Submerge completely. 6. Wash hands. 7. Boil utensils for 30 minutes. 8. Place sanitized utensils in common-use storage area. 9. Rinse brush in cold water and boil in utensil sanitizer. 10. Wash hands before touching sanitized items.	1. Utility room. 2. For patients with toilet and water supply in isolation unit, follow steps 1 through 4 in patient area. Take mechanically cleansed articles to utility room for sanitizing.	Refer to FM 12-10, for details on construction of field saritation devices. 1. Pour excreta into deep-pit or bored-hole latrine. *NOTE:* Follow local policy for use of calcium chloride (lime) for pre-treatment of excreta before disposal. 2. Pour bath water and other fluids containing soap with a soakage pit prepared with a grease trap. 3. Rinse with cold water. Discard water in soakage pit. 4. Scrub with brush and prescribed detergent. 5. Immerse reusable utensils in boiling water (immersion heater unit). Boil for 30 minutes. 6. Burn or bury disposable items.
Urinals, bedpans	Take covered utensil to utility room. Place directly into bedpan washer-sanitizer. Flush contents into sewerage system.	1. Use paper towel to activate flush value and steam valve. 2. Wash hands. 3. Steam for 3 minutes. 4. Remove from sanitizer. Inspect for residual stains. Scrub with brush and detergent p.r.n. Rinse. 5. Place sanitized utensils in common-use storage area.	Utility room.	
Solid wastes and refuse, all disposable articles.	Place in plastic or paper bag or wrap in newspaper before taking from unit.	Close bag to completely inclose contents. Drop bag into waste receptacle. Wash hands.	Patient unit or utility room, for collection for incineration.	Handle in the same manner in b, c, or d, as applicable.
Food trays, pitchers, water glasses, etc.	In patient unit, if toilet available, pour liquid wastes into toilet. Flush into sewerage. Otherwise, take tray to utility room.	1. Discard liquid wastes into hopper. Flush hopper. Use paper towel to turn on water faucet or flush valve. 2. Scrape all solid wastes onto paper serving dishes. Wrap and discard into waste receptacle. 3. Have "clean" assistant hold open large plastic bag or paper bag. Slide tray and nondisposable	Wrapped tray and nondisposable articles to food service for sanitizing in dishwasher.	1. May be same, depending on mess dishwashing facilities. Otherwise, dishes are scraped, washed with brush, immersed in boiling water, and boiled for 30 minutes in immersion heater setup of ward unit. 2. Discard food wastes (solid) for incineration. Discard liquids into soakage pit prepared with a grease trap.

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essentially the same as for any patient, but with increased emphasis on the principles of medical asepsis. Some patients will be confined to bed and will be very limited in the amount of self-care permissible; other patients may be allowed up and around within the confines of their room or unit area but must still depend upon nursing personnel to attend to many of their needs—the patient in isolation is quite limited in his self-sufficiency. Some major considerations in carrying out medical asepsis for the patient in isolation include—

a. Allowing adequate time for proper use of handwashing, masking, and gowning facilities and all other protective measures.

b. Having the supplies and facilities for isolation technique available in the location where they are to be used and set up ready for use.

c. Handling articles removed from or taken into contaminated areas in accordance with a predetermined, unvarying routine.

d. In some instances, assigning a "clean assistant" who remains outside the isolation unit, but who is on call to assist the worker within the unit. *For example,* it is the clean assistant who should hold open a clean bag or other wrapper into which a contaminated article is dropped; it is the clean assistant who obtains supplies from a clean area for the worker in the unit, etc.

e. Using disposable articles to the greatest extent possible; *for example,* paper cups and plates, plastic eating utensils; paper and plastic protective pads instead of rubber sheets; disposable treatment sets and trays; disposable syringes, needles, catheters, etc.

ROUTINE PROCEDURE— ON ENTERING THE PATIENT'S UNIT

1. Assemble any equipment needed for the patient.
2. Check utility room to insure designated area is prepared for temporary placement of contaminated articles removed from isolation unit.
3. Check supplies at entrance to unit and replenish p.r.n.
4. Place equipment to be taken into unit at entrance to unit. Place articles which are to be kept clean while in use (such as a watch) on a paper towel.
5. With clean hands, put on gown and mask.
6. Pick up equipment, open door, and enter unit, making the number of trips that are necessary. Pull screen or door closed, touching only the inside of the screen on door.

NOTE

Hands are now contaminated.

7. On completion of tasks and before leaving the unit, pick up and assemble at the exit all articles to be removed. Collect waste for disposal; collect all soiled linen items and place them in the laundry bag within the unit. Never allow waste disposal or laundry bag to become more than two-thirds full; replace immediately with clean collection bags. Always secure closure of waste bags before removing.
8. Before leaving, check to see that everything possible has been done for the patient's comfort and convenience—check his position, the signal cord, water and tissue supply, ventilation, light, etc. Ask the patient if there is anything he wishes you to do while you are there to do it.

ROUTINE PROCEDURE— ON LEAVING UNIT

1. Remove gown. Wash hands. Then remove and dispose of contaminated linen and wastes.

NOTE

Your hands are contaminated once you touch anything that has been in the isolation area.

   a. Deposit laundry bag from inside of unit into laundry bag on conveyor, using care not to touch outside of open bag.
   b. Take all contaminated utensils and waste inclosed in bag to utility room. Place on newspaper-covered surface temporarily.
   c. Use a paper towel to lift lid of waste can. Deposit waste bag in can and replace cover.
   d. Pour bath water, vomitus, and other liquid wastes into hopper. Use care to avoid splashing. Rinse utensils with cold water, discarding rinse water in hopper. Use paper towel when handling faucet and flush-lever. Place rinsed utensils on newspaper-covered surface temporarily.
   e. Place bedpan or urinal in bedpan washer-sanitizer, using paper towel to press down flush handle and turn on steam valve. Do not leave contaminated articles in utility room for someone else to clean. Complete all cleaning as soon as possible after use of item.
   f. Wash hands when completed.
2. For additional steps in caring for utensils and other contaminated equipment and articles, see table 5–7.

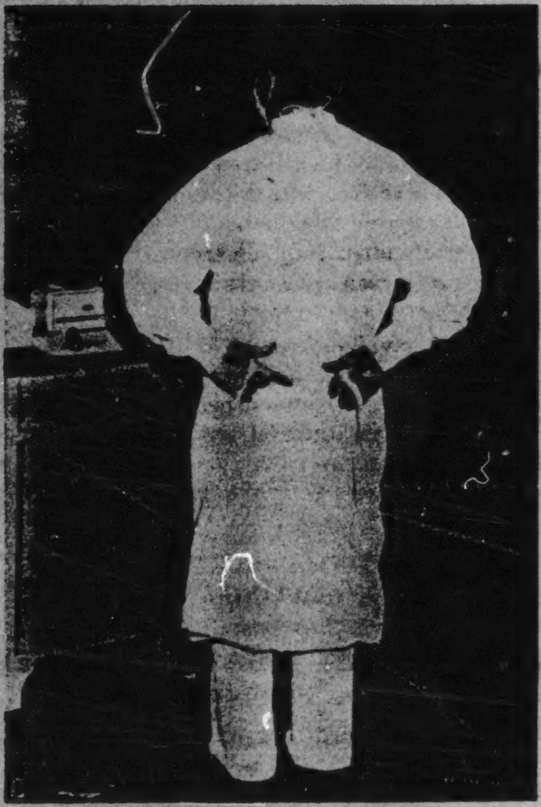

Figure 5-76. Fastening clean gown.

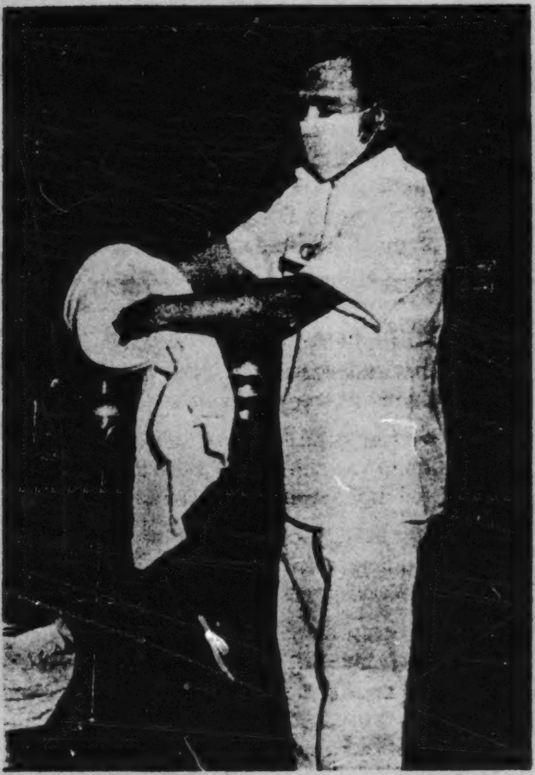

Figure 5-77. Discarding used gown.

8. Push sleeve cuffs above wrists to convenient working level.

Removing the Gown and Mask

1. Untie the belt and push sleeves up about 2 inches.
2. Wash hands without touching sleeve cuffs.
3. Untie neck strings of the gown.
4. Place fingers under the cuff and pull down the sleeve over the hand without touching the outside of the gown.
5. With hand inside sleeve, draw other sleeve down over hand.
6. Slip out of gown by working hands up to shoulder seams of gown.
7. Keeping hands inside under the shoulder seams, lift gown off shoulders. Roll gown away from you with the contaminated side inside (fig. 5-77).
8. Place gown in laundry bag.
9. Remove mask as described in paragraph 5-95 and place in contaminated container.
10. Wash hands.

5-97. Glove Technique

If the use of gloves is indicated when handling highly infectious materials, use clean plastic disposable gloves when they are available. If gloves are indicated for wound care or other procedures requiring surgical aseptic techniques, use sterile gloves, following sterile gloving procedure. In either instance, discard heavily contaminated gloves —do not attempt to rinse, wash, or return them to CMS.

PROCEDURE (CLEAN)

1. Wash hands.
2. Dry hands thoroughly with paper towels.
3. Put on gloves at entrance to unit, covering cuffs of gown with glove cuffs to protect all skin surfaces.
4. Remove gloves before leaving the unit by pulling glove cuffs down and turning contaminated surfaces to the inside. Discard gloves in waste receptacle within the unit.

5-98. Caring for a Patient in an Isolation Unit

The care of the patient in an isolation unit is

(1) When in close contact (within 3 feet) of a patient expelling droplet spray. The patient may also be required to wear a mask—this is determined by the medical officer.

(2) When handling contaminated linen as in bedmaking or removing linen from the unit or when cleaning in the unit. Even careful damp-dusting and wet-mop floor cleaning measures stir up some contaminated dust. Mask and gown should be worn at these times.

b. Rules When Using a Mask.

(1) Put on mask, with clean hands, before entering the unit. When a gown is also worn, put on the mask first.

(2) Change the mask at least every hour when prolonged wear is necessary and change it at more frequent intervals if it becomes damp.

(3) Once the mask is removed from nose and mouth, discard it in the designated container. Do not wear it bib-fashion around the neck or put it in a pocket.

PROCEDURE

1. Wash hands.
2. With clean hands, remove a clean mask from its container.
3. Open mask by pulling on strings or elasticized side loops.
4. Fit the mask over the nose and mouth; slip loops over ears or tie strings at back of head and neck. Take time to fit the mask well because once it is on, it should not be readjusted.
5. When removing the mask, wash hands before touching the ear loops or strings (these are considered clean).
6. Handle discarded mask by loops or strings only; discard the mask by dropping it into lined, step-on can.

NOTE

> When reusable masks must be used, line discard container with a mesh bag (laundry net) obtained from linen supply; this bag is then tied and dropped into the soiled linen bag. Clean, laundered masks are sent to CMS for rolling, autoclaving, and distribution to using activities in a suitable container (usually a canister, but it may be a paper bag). Reusable masks are sterilized by autoclave as a safety factor because of the multiple-handling procedures necessary in sorting and rolling for distribution.

7. Wash hands.

5-96. Gown Technique

a. Protective Gowns. Gowns are worn to protect the wearer's clothing. Gowns are worn by—

(1) Personnel giving contact care to the patient. This includes bathing, bedmaking, giving treatments, taking TPR and BP, giving parenteral medications.

(2) Personnel handling contaminated linen, damp-dusting, or otherwise cleaning the patient unit.

(3) Visitors when in contact with the patient or his immediate surroundings; *for example*, standing at the bedside or sitting in a chair within the unit.

b. General Precautions When Using Gowns.

(1) Supply enough gowns at the entrance to the unit so that a clean gown is available for each individual who enters the unit. On leaving the unit, remove and discard the gown into the laundry bag outside the unit. This "discard technique" is the simplest and the safest procedure. Other techniques—in which the gown is removed, hung up, and reused—are more apt to result in contamination of clothing and environment and are therefore not recommended.

(2) Check clean gowns before placement at point of use to insure that they have no holes, that ties and belt are intact, and that sleeves have knit cuffs. Send defective gowns for linen repair and place only clean, usable gowns in the gown supply at the entrance to the isolation unit.

PROCEDURE (DISCARD TECHNIQUE)

Putting On The Gown

1. Remove wristwatch.
2. Wash hands.
3. Put on mask, if indicated.
4. Take gown from cabinet or table.
5. Open gown full length, thrust hands through sleeves, and draw the neck of the garment into place. Tie the gown at the neckband in the back.
6. Grasp edges of the back of the gown and lap one edge over the other to completely cover clothing.
7. Fasten belt ends in a bowknot at the back snugly enough to hold gown folds in position to cover clothing (fig. 5-76).

Plastic or paper bags
Laundry bag and conveyor
Tag—"Contaminated Linen" (color-coded)

For Use In Utility Room:
Newspapers
Toilet brush
Can or pitcher of prescribed germicide-detergent solution
Basin of prescribed germicide-detergent solution
Hand brush p.r.n.
Paper towels

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[1] Refer to page 5–63 for individual thermometer set up.

[2] For handwashing when handwashing with running water is not available outside and immediately adjacent to the isolation unit.

Procedure

1. Assemble all equipment to be taken to the unit at the same time. Place all appropriate articles on a cart to avoid extra trips.
2. Screen off the entire unit if it is set up in a multiple-bed ward. Use cubicle curtains for side screens and portable screens at the foot of the bed, placing screen to allow adequate space for access to foot-of-bed area within the isolation unit.
3. Attach "Isolation" sign to outside of screen at cubicle or to door of room.
4. Inform all other patients that the isolation unit is off limits to them.
5. Place within unit, near the exit:
   a. Laundry bag, for soiled linen.
   b. Step-on can, lined with plastic or paper bag.
6. Arrange equipment for convenience and immediate accessibility outside entrance to unit:
   a. Cabinet (or table) for clean gowns, disposable masks, paper towels, a few extra paper or plastic bags, 2 extra laundry bags.
   b. Handwashing unit.
   c. Step-on can lined with plastic or paper bag—for towel and mask disposal.
   d. Laundry bag in conveyor (color-coded "Contaminated Linen" tag, tied to cord or flap of bag; 12-inch, fold-over cuff).
7. Arrange equipment for convenience and immediate accessibility in designated area of utility room:
   a. Counter or table area, with top surface protected with four layers of newspaper—for temporary placement of contaminated utensils.
   b. Basin of germicide-detergent solution—for immersion of contaminated articles p.r.n.
   c. Toilet brush in container (may use size 10 tin can) of detergent-germicide solution.

5–94. Handwashing and Hand Care

The greatest single factor in preventing the spread of disease is washing the hands before and after caring for a patient. Because of emphasis on the necessity for handwashing after contact with the patient and his contaminated articles, the need for washing hands before approaching the patient in isolation is sometimes neglected; the patient in isolation needs all possible protection to keep him from being exposed to new infection or reinfection.

PROCEDURE

1. Remove rings and wristwatch before entering the unit. Pin rings inside the uniform pocket and do not wear them when in patient care areas.

NOTE

> If a wedding band is not removed, be sure to move it up and down while washing hands to cleanse skin under and around the metal. Place wristwatch on clean paper towel on the table outside the unit. When needed inside the unit, carry the watch in on the towel.

2. Follow recommended handwashing procedures (para 5–6), with these additions upon leaving the unit:
   a. *Running water technique.* Repeat lather and friction steps, for a total of 2 minutes washing.
   b. *Basin technique.* Change solution q. 2 h. unless a more frequent change is required because of heavy use.
   c. *Hand care.* Dry hands thoroughly and use hand lotion regularly to keep skin in good condition. Rub lotion into cuticles as well as skin surfaces to help prevent hangnails and chapped, irritated skin.

5–95. Mask Technique

a. General. Masks are worn to protect the worker from inhaling disease organisms spread by droplet spray and from dust present during bedmaking, linen handling, and unit cleaning procedures. Although there are differences of opinion on how effective the types of masks usually available are as a filter barrier, the use of a mask is recommended in the following instances:

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Table 5–6. Nursing Care—Selected Communicable Diseases—Continued

Disease and causative organism	Source of infection, mode of transmission	Incubation period, communicable period	Common symptoms, possible complications	Points in nursing care
TYPHOID FEVER—Continued				*Terminal disinfection:* Thorough cleaning, airing, and sunning of room.
TYPHUS: FEVER: Caused by rickettsia prowazeki: A. Epidemic. B. Endemic.	*Source:* A. Epidemic type, infected persons. B. Endemic type, infected rats. *Spread:* A. Epidemic type, bite of infected louse, or feces of infected louse inoculated into bite or wound. B. Endemic type, bite of infected flea.	*Incubation:* 6–15 days. *Communicable:* Not from man to man. Patient is infective to lice during fever and possibly 2–3 days after temperature is normal.	*Symptoms:* High fever, chills, severe headache, severe back and generalized body aches and pains. Rash about fifth day covers trunk but avoids hands, feet, face. Cough, bronchitis. Pulse slower than fever would indicate. May become stuporous, delirious. *Complications:* Bronchitis, bronchopneumonia, otitis media, mastoiditis.	Place in room or ward after all lice and nits have been removed from his person. Patient and bedding should be dusted with DDT once a week during febrile period. Force fluids during period of high fever. Care is similar to that of typhoid fever. *Disinfection:* As for a general hospital patient. Handle linen carefully.

				wounds. Incinerate paper handkerchiefs and dressings. *Terminal disinfection:* Thorough cleaning of room; air for 24 hours.
TUBERCULOSIS: (Pulmonary): Caused by tubercle bacilli.	*Source:* Person with "open" tuberculosis (sputum, nose and throat discharges contain tubercle bacilli). Milk from tubercular cattle. *Spread:* Direct or indirect contact with infectious persons, by means of coughing, sneezing, droplets. Infections rarely occur from casual contact but usually from long and close exposure.	*Incubation:* Variable. *Communicable:* As long as the tubercle bacilli are discharged by the patient.	*Symptoms:* Fatigue without cause, loss of weight, cough of 3 or more weeks duration which does not respond to treatment. Loss of appetite and digestive disturbances. Nightsweats. Afternoon temperature elevation. Tubercle bacilli may be found in sputum and/or gastric washings. Lesion may be found on chest X-ray. *Complications:* Spread, pleurisy with or without effusion, hemorrhage, atelectasis, spontaneous pneumothorax.	Isolation in separate room or special ward. Tuberculosis is a long-term disease; therfore, morale is an important factor. Rest is an essential of treatment. Teach patient ways to protect himself and others from infection. Plan nursing care in accordance with TB MED 231, Prevention of Spread of Tuberculosis in Armed Forces Hospitals, and TB MED 236, Management of Pulmonary Tuberculosis. *Disinfection:* All articles in contact with patient. Incinerate paper handkerchiefs and sputum cups.
TYPHOID FEVER: Caused by typhoid bacillus.	*Source:* Feces or urine of infected persons and carriers. *Spread:* Direct contact with patient or carrier, indirectly by contaminated water, food, milk, shellfish, flies.	*Incubation:* Variable; average 2 weeks, usual range 1–3 weeks. *Communicable:* From first symptoms throughout convalescence or until excreta is repeatedly negative for organism.	*Symptoms:* Variable, lasts 4–6 weeks. First week: Constant severe headache, irregular pulse, cough, bronchitis, constipation or diarrhea. Epistaxis (nose bleed), fever higher each p.m. until it reaches 104°–105°F. Second week: Fever remains high, heavily coated tongue, sores, rose spots on abdomen, pulse slow in proportion to temperature, dullness, lethargy, low muttering delirium, eyes open and staring. Third week: Gradual decline in temperature, beginning of convalescence. Convalescence is long, may be 2 weeks to several months. *Complications:* Intestinal hemorrhage may occur in second or third week. Perforation of intestine may occur late in disease. Phlebitis, bronchitis, pneumonia, cholecystitis.	Isolate in room with screened door and windows to exclude flies. Plan care to provide maximum rest for patient. During period of high fever, take rectal temperatures, give tepid sponges, ice cap to head, mouth care q2h. Watch bony prominences closely for pressure areas. Avoid pressure on abdomen when bathing patient. Stay with patient during delirium. Allow patient to chew gum if he is able. If constipation is present, enemas may be ordered; give very slowly. Cathartics are not given because of danger of perforating intestines. Diet—High caloric, high carbohydrate in frequent small meals. Force fluids. Patient may be fed because of lethargy and poor appetite. *Disinfection:* All articles in contact with patient. Disinfect excreta before disposal when municipal sewerage is not available. Incinerate all burnable materials.

Table 5-6. Nursing Care—Selected Communicable Diseases—Continued

Disease and causative organism	Source of infection, mode of transmission	Incubation period, communicable period	Common symptoms, possible complications	Points in nursing care
POLIOMYELITIS—Continued				packs are ordered (usually) as soon as diagnosis is made. Watch for nasal voice, hoarseness, difficulty in swallowing, twitching of facial muscles characteristic of bulbar type. Should respiratory paralysis develop, patient may be placed in a respirator. *Disinfection:* All articles soiled by nose and throat discharges. Incinerate paper handkerchiefs. If municipal sewerage is not available, disinfect feces before disposal.
RUBELLA: (German measles): measles): Caused by a virus.	*Source:* Secretions from nose and throat. *Spread:* Droplet or direct contact with infected person; indirectly by articles freshly soiled with secretions.	*Incubation:* 14 to 21 days; usually 18 days. *Communicable:* For about one week before and at least 4 days after onset of rash. Highly communicable.	*Symptoms:* Mild fever, rash of variable character, sometimes resembling that of measles (Rubeola), scarlet fever, or both. Few or no constitutional symptoms; almost always enlargement of regional lymph nodes—particularly postauricular (behind the ears), suboccipital or postcervical (back of neck). *Complications:* None in the patient but causes significant proportion of congenital deformities in babies whose mothers have had the disease in first 4 months (first trimester) of pregnancy.	Isolation where contacts include a woman in early pregnancy. If isolated, for 5 days after onset. General nursing care for bed rest patient with mild, acute, febrile illness.
SCARLET FEVER: Caused by hemolytic streptococci.	*Source:* Discharge from nose and throat, abscesses, wounds of infected persons. Also carriers. *Spread:* Direct contact with patient or carrier. May be airborne. Articles freshly soiled by discharges in infected person or carrier; by contaminated milk and milk products.	*Incubation:* Usually 2-5 days. *Communicable:* Until few days past clinical recovery, all abnormal discharges stopped, open sores or wounds have healed.	*Symptoms:* Sudden onset, sore throat, vomiting, rapid rise in temperature. Tongue heavily coated, in few days becomes bright red, swollen, "stawberry tongue." Forehead and neck flushed, region around mouth is usually pale. Usually a fine rash, blanching on pressure; appears on neck, chest, axilla, elbow, groin, inner aspect of thigh. Pulse is rapid, appetite is poor; bowels constipated, urine scanty. Restlessness, headache, insomnia, delirium, and convulsions may occur during disease. *Complications:* Cervical adenitis, otitis media, nephritis, arthritis, rheumatic fever, endocarditis.	Isolation in separate room. Complete bed rest until 24 hours after temperature returns to normal. Tepid sponges may be given to reduce temperature. Addition of sodium bicarbonate to bath water may relieve itching. Olive oil or cocoa butter applied during desquamation (peeling of skin) period adds to patient's comfort. Never use alcohol during desquamation stage. Give mouth care q4h; throat irrigations or gargles may give relief during sore throat stage. Accurately measure intake and output of fluids and semisolids during acute stage. *Disinfection:* All articles soiled with discharges from nose, throat, sores,

PNEUMONIA: **A. Acute lobar: Caused by pneumococci.**	*Source:* Probably discharges from nose and mouth of infected persons and carriers. *Spread:* By direct contact with infected person and by droplets. Indirectly by articles freshly soiled by such discharges.	*Incubation:* Possibly 1–3 days. *Communicable:* Unknown, thought to be until organisms no longer present in discharges. Possibly by minute suspended particles containing infectious agent.	*Symptoms:* Abrupt onset with chill. Rapid rise in temperature to 104°–106° F., skin hot and dry; malaise and headache; pain in chest; patient lies on affected side. Flushed face, cyanosis about lips. Herpes on lips. Increased respirations and respiratory grunt. Cough with tenacious rusty sputum. Pulse full and bounding. Delirium may be present. *Complications:* Spread to another part of lung, pleurisy with effusion, empyema, pericarditis, endocarditis, meningitis.	Isolate patient in a separate, warm, well-ventilated room free from drafts. Encourage patient to rest and relax. Complete bed rest is basic treatment. Plan procedures so as to disturb patient as little as possible. Change position every 3–4 hours. Daily bath; occasional back rub with lanolin or cocoa butter for elderly patients may prevent dry itching skin. Special mouth care every 3 hours. Apply ointment to lips to keep them soft. Force fluids. Diet as desired. Administer oxygen as necessary. *Disinfection:* All articles soiled by nose and throat discharges. Incinerate paper handkerchiefs. *Terminal disinfection:* Thorough cleaning; air room for 24 hours.
B. Primary atypical: Caused by virus.	*Source:* Discharges from the nose and throat. *Spread:* By direct contact with infected person. Indirectly by articles freshly soiled by nose and throat discharges. Mild unrecognized infections may help spread of disease.	*Incubation:* Not definite, may be 7–21 days. *Communicable:* Unknown length of time.	*Symptoms:* Chilliness, fatigue, malaise, fever, range 99°–104° F. Intense headache. Painful and exhausting cough with scant sputum. *Complications:* Pericarditis, pleurisy, empyema, encephalitis.	Similar to points listed under A; bed rest for several days after temperature returns to normal.
POLIOYMELITIS: **(Infantile Paralysis): Caused by virus of poliomyelitis.**	*Source:* Discharge from nose, throat, intestinal tract of acutely ill and/or convalescent patient, carrier. *Spread:* By direct contact and droplets spread through close association with infected persons.	*Incubation:* Usually 7–14 days. May be 3–35 days. *Communicable:* Latter part of incubation period and first week of illness (not definite).	*Symptoms:* Three stages. First stage: Gastrointestinal upset, fever, headache, malaise. Second stage: Meningeal irritation, severe headache, pain and stiffness in back of neck and limbs, muscle spasm. Third stage: Severe involvement of nervous system, paralysis. Patient may progress to all three stages, or disease may be limited to first and/or second stage. Often paralysis is the first sign of the disease. *Complications:* Atelectasis and pneumonia in patient with respiratory paralysis. Renal calculi, atrophy of paralyzed muscles.	Isolation in separate ward or room. Complete bed rest on a firm bed. Place fracture board under mattress. Use a covered footboard separated from mattress by blocks to prevent pressure of bedding on toes and to provide firm base for soles of feet when patient is in prone position. Woolen or cotton blankets should be next to patient. Physical and mental rest is essential; avoid drafts and glaring lights. Hands should be warm when touching patient. Maintain body in good alinement. Baths are frequently omitted during acute stage. When bathing, use gentle sponging movements and dry by blotting rather than rubbing. Fluids during acute stage, diet as desired later. Hot

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Table 5-6. *Nursing Care—Selected Communicable Diseases*—Continued

Disease and causative organism	Source of infection, mode of transmission	Incubation period, communicable period	Common symptoms, possible complications	Points in nursing care
MUMPS—Continued	freshly soiled with saliva of such person.		glands often swollen and tender. Features are distorted. Movements of jaw are restricted and painful. May affect one or both sides. *Complications:* Orchitis, oophoritis, pancreatitis, mastitis.	frequent mouth washes or gargles. Force fluids and semisolids. Avoid acid fruit juices. A scrotal bridge may be ordered for male patient. *Disinfection:* All articles in contact with nose and mouth discharges. Incinerate paper handkerchiefs.
PERTUSSIS: (Whooping Cough): Caused by pertussis bacillus.	*Source:* Discharges from throat of infected persons. *Spread:* By direct contact with infected persons, by droplet infection. Indirectly by articles freshly soiled with such discharges.	*Incubation:* 7–10 days. *Communicable:* From 7 days after exposure to 3 weeks after onset of typical paroxysms.	*Symptoms:* Chilliness, malaise, moderate fever, coryza, dry hacking cough. Cough gradually becomes severe until characteristic whoop is noted. The paroxysmal stage is marked by coughing at intervals of varying frequency. Repeated paroxysms of coughing, loss of breath, whooping, and vomiting leave the patient exhausted, perspiring, and apparently dazed. *Complications:* Bronchopneumonia, hernia, hemorrhage, prolapse of rectum, convulsions.	Isolation in a separate, well-ventilated room. Patient should be kept quiet. Tight abdominal binder may give some support during paroxysms. Serve bland nourishing foods, neither very hot nor very cold. If patient vomits soon after eating, feed again. *Disinfection:* All articles soiled with discharges from nose and throat. Incinerate paper handkerchiefs. *Terminal disinfection:* Thorough cleaning; air room for 24 hours.
PLAGUE: **Caused by plague bacillus.** **Types:** **Pneumonic.** **Bubonic.**	*Source:* Infected rodents and patients. *Spread:* Direct by droplet, nose, and throat discharges in pneumonic form. Bubonic transmitted from rodent to man by bite of flea.	*Incubation:* Bubonic 2–6 days. Pneumonic 3–4 days. *Communicable:* Pneumonic during active stage. Bubonic–not communicable from man to man.	*Symptoms:* Pneumonia forms: Bronchopneumonia develops rapidly, sputum bloodstreaked and watery. This form is usually fatal in short time. Bubonic forms: Sudden onset: headache, vomiting, prostration. Delirium, conjunctiva injected, facial expression of weariness characteristic. Tongue furred and swollen, subcutaneous hemorrhages giving rise to term "Black Death." Lymph glands become swollen, painful, and may suppurate, especially those of the neck, groin, and axilla. *Complications:* High mortality rate, secondary pneumonia, and pleurisy.	Isolation in room with screened windows. In pneumonic type: Worker wears close-fitting hood, goggles, coveralls, rubber gloves, Nursing care that of pneumonia. Bubonic type: Nursing care is that of typhoid fever. The patient is very ill and needs constant care. *Disinfection:* In pneumonic type, all sputum, tissues, contaminated with mouth and nose secretions must be burned. In bubonic type, burn all dressings and bandages. Both types: all contaminated equipment must be disinfected. Urine and feces of patients must also be disinfected. Area of original infection should be treated to destroy rats and fleas. *Terminal disinfection:* Thorough cleaning; air room 48 hours. Bodies of persons dying of plague should be handled with strict aseptic precautions.

				safety measure. Sweating stage follows hot stage, temperature drops rapidly, profuse diaphoresis. Force fluids, change linen frequently, keep dry, avoid drafts to prevent chilling patient. Three stages may last 6–10 hours. Observe and record time, severity, and duration of each stage.
MEASLES: (Rubeola): Caused by a virus.	*Source:* Secretions from nose, throat, eyes. *Spread:* By direct contact with infected person; by droplet. Indirectly by articles freshly soiled with discharges from mouth, nose and eyes.	*Incubation:* 10 days from exposure to onset of fever; 13–15 days to appearance of rash. *Communicable:* From 4 days before until 5 days after appearance of rash.	*Symptoms:* Coryza, sneezing, cough, nausea, vomiting, chilliness, fever, small grayish white spots at gumline (Koplik spots.) Rash appears third or fourth day; starts about ears, face, trunk and extremities. Fever increases during eruption, subsides as rash fades. *Complications:* Bronchopneumonia, otitis media, laryngitis, encephalitis.	Isolate in light airy room during period of communicability. Avoid direct or glaring light; protect patient from drafts. Complete bed rest until temperature returns to normal. When bathing, use very little soap; pat rather than rub dry. Itching skin may be relieved by a 5-percent solution of sodium bicarbonate. Petrolatum may be applied about nares and lips. Offer mouth wash and gargles frequently. *Disinfection:* All articles in contact with discharges. Incinerate paper handkerchiefs and dressings soiled with discharge from nose, throat, eyes. *Terminal disinfection:* Thorough cleaning of room; air for 24 hours.
MENINGITIS, MENINGOCOCCAL: Cerebrospinal Fever.) Caused by cocci.	*Source:* Discharges from nose and throat of patient and carriers. *Spread:* By direct contact with patient or carriers and by droplet. Indirectly by articles freshly soiled with infectious discharges.	*Incubation:* 2–10 days. *Communicable:* Until nose and throat discharges are negative for meningococci.	*Symptoms:* Sudden onset; fever, intense headache, nausea, vomiting, petechial skin rash; neck becomes stiff; patient stuporous or lapses into coma. Patient may assume opisthotonos position (spine arched backward to an extreme degree). *Complication:* Pneumonia.	Isolate in quiet, slightly darkened room. Change patient's position frequently. Use small pillows and other devices for comfort. Patient is very sensitive to noise, light, and touch. Handle him gently. Give frequent back care to avoid pressure sores. Give oral hygiene before and after feeding. Apply ointment about lips. Protect eyes from bright lights. *Disinfection:* All articles soiled by nose and throat discharges. Incinerate paper handkerchiefs. *Terminal disinfection:* Thorough cleaning of room; air for 24 hours.
MUMPS: (Infectious Parotitis). Caused by virus of mumps.	*Source:* Saliva of infected person. *Spread:* By droplet and direct contact with infected person. Indirectly by articles	*Incubation:* 12–26 days. *Communicable:* From 2 days before glands swell until swelling subsides.	*Symptoms:* Chilliness, malaise, moderate fever, pain on swallowing and chewing. Swelling below and in front of ear. The surrounding tissues are edematous; the submaxillary	Isolation for period of communicability. Complete bed rest until after swelling has subsided. Heat or cold may be applied to affected area if desired. Special mouth care with

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Table 5–6. Nursing Care—Selected Communicable Diseases—Continued

Disease and causative organism	Source of infection, mode of transmission	Incubation period, communicable period	Common symptoms, possible complications	Points in nursing care
HEPATITIS—Continued	taminated water, milk, food, including oysters and clams.			tact with these secretions; thorough heat sterilization of syringes, needles and other instruments. *Terminal disinfection:* Use disposable rectal and gastrointestinal tubes, syringes, needles, etc., whenever possible. Break and dispose of rectal thermometers instead of attempting terminal sterilization and reuse by another patient.
B. SERUM (SH): **Caused by: (See A, above).**	*Source:* Blood or blood products from an infected person. *Spread:* By parenteral inoculation of human blood or blood products or by use of syringes, needles, or other instruments contaminated with traces of such materials.	*Incubation:* 50 to 160 days, usually 80 to 100 days. *Communicable:* Unknown. Some blood donors are known to have been continuously or intermittently infective for years.	*Symptoms:* As in A, above. *Complications:* Higher fatality than in IH (A, above).	No isolation—not known to be communicable except by injection. Bed rest may be prolonged with very gradual restoration of activities; diet and I & O as in A, above. *Disinfection:* Steam under pressure, dry heat, or ethylene oxide gas sterilization of syringes, needles, and stylets for finger puncture. *NOTE.* Use disposable equipment when possible.
INFLUENZA: **Caused by influenza virus.**	*Source:* Probably discharges from mouth and nose of infected person or carrier. *Spread:* By direct contact with discharges and droplet infection from infected person or carrier, possibly airborne. Indirectly by articles freshly soiled by discharges.	*Incubation:* 24–72 hours. *Communicable:* Possibly from incubation until after fever subsides.	*Symptoms:* Chills, fever, malaise, generalized aches and pains; intense headache; cough, sputum scant and watery at first, increases in amount and becomes mucopurulent; mental depression; prostration out of proportion to symptoms. *Complications:* Bronchitis, acute sinusitis, otitis media, pneumonia.	Isolation in separate room or ward. Complete bed rest until 24 hours after temperature returns to normal. Tepid sponges to refresh patient. Ice cap to relieve headache. Warm gargles may relieve throat irritation. Steam inhalations may relieve cough. Maintain cheerful attitude toward patient; keep room light and pleasant. Force fluids, diet as desired. *Disinfection:* All articles in contact with nose and throat discharges. Incinerate paper handkerchiefs.
MALARIA: **Caused by protozoan parasite (four types).** **Plasmodium vivax.** **Plasmodium faciparum.** **Phasmodium ovali** **Plasmodium malariae.**	*Source:* The blood of infected person. *Spread:* By bite of infected mosquito (Anopheles).	*Incubation:* Varies with species of infecting organism and the number infected. *Communicable:* As long as sexual form or organism exists in blood in sufficient quantities to infect anopheles mosquito.	*Symptoms:* Shaking chills, periodic fever, headache, malaise, skin hot and flushed during chills and high fever. After chills, profuse diaphoresis, extreme thirst, delirium, spiking temperature, backache. *Complications:* Anemia, hemoglobinuria, frequent relapses.	Room with screened door and windows. If not available, place netting over bed. Bed rest during paroxysms of chills and fever. In cold stage, apply blankets, hot water bottles, urge hot drinks. As hot stage develops (immediately after cold stage) gradually remove heat. Tepid sponges and ice cap to head may help during this stage. Force cold fluids. Place small pillow under small of back to relieve ache. If delirous, apply sidebars to bed as

DYSENTERY: A. Amebic (amebiasis): Caused by endamoeba histolytica.	*Source:* Feces of infected persons, especially carriers. *Spread:* Indirectly by foods, articles, water, flies, soiled hands, or infected food handlers.	*Incubation:* 3 days to several months, commonly 3–4 weeks. *Communicable:* During course of infection and until feces are negative for ameba.	*Symptoms:* Diarrhea and abdominal cramps. Fever; weight loss; general debility; diarrhea, often bloody or watery stools, foul odor to feces. May be alternate constipation and diarrhea. *Complications:* Liver abscess, hepatitis, lung abscess.	Isolate during acute stages. Room with screened door and windows. Complete bed rest during acute stage. Teach patient to wash hands after defecation and before handling food. Measure intake and output. Chart description of each stool. During acute stage, feed patient frequent small meals high in carbohydrates; after acute stage, diet should be high in protein. Avoid fruit juices, leafy vegetables, salads. When emetine hydrochloride is being administered, watch patient for symptoms of visual disturbance, increased pulse rate, fall in blood pressure, pallor or cyanosis. *Disinfection:* All articles in contact with discharges from alimentary tract. Disinfect feces before disposal if municipal sewerage is not available. *Terminal disinfection:* Thorough cleaning.
B. Bacillary (shigellosis): Caused by various species of shigella.	*Source:* Feces of infected persons and carriers. *Spread:* Indirectly by infected person or carrier, also contaminated flies.	*Incubation:* 1–7 days. *Communicable:* During disease and until feces are negative for organisms.	*Symptoms:* Mucus or bloody diarrhea, abdominal cramps, tenesmus, fever, prostration. In severe cases, marked dehydration, abdominal distention, coma. *Complications:* Arthritis, pneumonia.	Room with screened door and windows. Bed rest depends upon the severity of disease. In acute stage, prevent chilling; keep room warm and quiet. Because disease may be of long term duration and be debilitating, daily baths with special attention to bony prominences are important. Devices for comfort should be employed where useful. Special mouth care q3h; force fluids during acute stage, avoid milk. Give frequent small meals, gradually return to normal diet. *Disinfection:* Same as for amebic.
HEPATITIS: A. Infectious (IH): Caused by unknown agent; a filterable agent has been demonstrated in experimental infection of volunteers.	*Source:* Feces, urine, and blood from infected persons *Spread:* Intimate person-to-person contact by fecal-oral route with respiratory spread possible; transfusion of whole blood, injection of blood serum or plasma from infected persons; con-	*Incubation:* 15 to 50 days, commonly 25 days. *Communicable:* Unknown—possibly from several days before to usually not more than 7 days after onset.	*Symptoms:* Fever, anorexia, nausea, malaise, abdominal discomfort, jaundice, usually prolonged convalescence. *Complications:* Rarely acute necrosis of liver; case fatality under 1%.	Isolation during first week of illness. Bed rest during the acute stage; frequent small feedings high in carbohydrate during period of anorexia. Measure intake and output; urge fluids. Gradual restoration of activity and full hospital diet. *Disinfection:* Feces, nose and throat secretions, and all articles in con-

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NOTE

Specific drug therapy (the use of a drug that is particularly effective in destroying a particular organism) for an increasing number of communicable diseases usually reduces the period of communicability, the severity of symptoms and possible complications, and the requirements for intensive nursing care in many of these diseases.

Table 5-6. Nursing Care—Selected Communicable Diseases

Disease and causative organism	Source of infection, mode of transmission	Incubation period, communicable period	Common symptoms, possible complications	Points in nursing care
CHICKEN POX: **(Varicella): Caused by virus.**	*Source:* Secretions of skin lesions, nose and throat of infected persons. *Spread:* By direct contact with discharges from lesions, nose, and throat of infected persons. Indirectly by articles freshly soiled with such discharges.	*Incubation:* 2–3 weeks. *Communicable:* from 1 day before until 6 days after the appearance of first crop of vesicles. *NOTE.* Chicken pox is one of the most readily communicable of diseases.	*Symptoms:* Mild chill and fever. Pain in back and legs. Maculopapular rash appears in 24 hours, followed by vesicular rash lasting 3–4 days. Rash first appears on trunk and covered portions of body. Different stages of rash may be on same region of body at same time, occurring in successive crops. Lesions may appear on scalp and mucous membranes. *Complications:* Secondary skin infection, pneumonia, conjunctivitis.	Isolate in separate room. Complete bed rest until 24 hours after temperature returns to normal. Caution patient against scratching lesions. Pat, rather than rub, skin dry when bathing patient. Use care in combing his hair. Avoid loosening scabs. Lotions, if ordered, may be applied to skin for relief of itching. Force fluids. Diet as desired. *NOTE.* Special care is needed when lesions are on mucous membranes of mouth, throat, or genitalia. *Disinfection:* All articles in contact with discharges. Incinerate paper handkerchiefs and dressings soiled with discharges. Terminal disinfection: Thorough cleaning of room; air for 24 hours.
COMMON COLD: **Caused by one or more viruses.**	*Source:* Secretions from nose and throat of infectious persons. *Spread:* By direct contact with infected person. By cough or sneeze of infected person. Indirectly by articles freshly soiled with nose and throat discharges.	*Incubation:* 12–72 hours. *Communicable:* During incubation and early stage of disease.	*Symptoms:* Sudden onset; slight fever, chilly sensations, coryza, general lassitude, vague aches and pains in back and limbs. *Complications:* Bronchitis, pneumonia, sinusitis, otitis media.	Isolation as can be accomplished by bed rest during the acute stage. Caution patient against nose blowing with both nostrils occluded. Apply cold cream or bland ointment to upper lip and about nares. Force fluids. Diet as desired. *Disinfection:* All articles in contact with discharges. Incinerate paper handkerchiefs soiled with discharges.
DENGUE: **(Breakbone Fever): Viruses of dengue fever.**	*Source:* Blood of infected persons one day before and up to 5 days after onset. *Spread:* By bite of mosquito (Aedes Aegyptae) infected by biting a patient during the above period. The mosquito becomes infectious after an interval of 8–11 days, and remains so.	*Incubation:* 3–15 days. *Communicable:* From day before onset until the fifth day of disease.	*Symptoms:* Sudden onset; high fever, intense headache, joint and muscle pains, irregular eruption. Intense pain in eyes may be a complaint. *Complications:* Rare; prolonged feeling of fatigue and depression may be present during convalescence.	Room with screened door and windows for 5 days. Bed rest during fever period. Ice cap to head. Cradle to keep top covers off painful joints. Calamine lotion to relieve itching. Protect eyes from direct or strong light. Cold compresses to eyes may be soothing. Urge patient to keep eyes closed as much as possible. *Disinfection:* As for general hospital patient.

spread of pathogenic organisms; maintaining adequate space (a distance of 5 feet) between beds; and keeping wards clean, dustfree, and well ventilated. When these measures are applied consistently, there is a large measure of built-in protection against the spread of communicable disease from an undiagnosed or unrecognized source.

(2) *Surgical asepsis.* Patients being treated in both surgical and medical wards require the use of surgical aseptic techniques to supplement the basic protective measures used in medical asepsis. Confusion sometimes results from erroneously thinking that medical and surgical asepsis measures require different emphasis when applied on a medical ward from those when applied on a surgical ward. What is required is an understanding of what is meant by "medical aseptic technique" and "surgical aseptic technique." A differentiation between some major considerations is outlined in table 5-5.

d. Nursing Care of Communicable Disease. Preparation for the provision of good nursing care includes knowledge of the duration and stages of the disease, techniques of isolation appropriate to the case, concurrent and terminal disinfection measures, comfort measures for the patient, diagnostic tests and specimens required, therapeutic measures usually ordered, observation for special signs and symptoms, and complications which may occur. For a brief description of some selected communicable diseases, along with pertinent points in nursing care, see table 5-6. (For additional information, refer to Control of Communicable Diseases in Man, 10th Edition, 1965, an official report of the American Public Health Association. This publication is available in every AMEDD medical library.)

5-93. Isolation Techniques

Isolation technique is a method of carrying out medical asepsis while caring for a patient with a communicable disease. It consists of: (1) setting up an isolation unit, (2) confining the patient to the unit, (3) using handwashing and protective clothing for individuals who care for or visit the patient, and (4) decontaminating (disinfecting) or destroying materials and utensils coming in contact with the patient. The medical officer determines the necessity for isolating the patient, writes the order, and explains the necessity of this treatment measure to the patient. In general, nursing personnel then have the responsibility of setting up and carrying out an approved form of isolation technique. Isolation technique practices vary from one AMEDD hospital to another—usually because of facilities available, particularly on availability of facilities for handwashing with running water and separate toilet and bath facilities for the patient on isolation. Local hospital procedures must be strictly followed. The procedures discussed in this section are typical of those used for isolation of a patient on a noncommunicable disease ward.

SETTING UP THE ISOLATION UNIT

a. *Location.* Use a single room, preferably with private toilet facilities. If such a room is not available, select a corner area of a multiple-bed room or ward in order to reduce proximity to other patients, and define the isolation unit by using cubicle curtains and portable screens to set it off from adjacent common-use areas.

b. *Designation of Contaminated and Clean Zones.*

- *Contaminated zones.* These include the interior of the patient's unit area and all of its contents; all floors; designated areas in the utility room to which contaminated materials may be brought for cleansing purposes; and interior of all sinks, hoppers, commodes, waste containers, and soiled linen hampers.
- *Clean zones.* These include offices, linen rooms, supply closets, nonisolated patient units; and treatment rooms. Everyone must be aware of these clean zones and be careful not to contaminate them by bringing into them any article from a contaminated zone that has not been disinfected.

Equipment

For Use Within Unit:
    Usual bedside equipment
    Thermometer, individual setup[1]
    Laundry bag
    Step-on can
    Plastic or paper bags
For Use At Entrance To Unit:
    Portable screens (if in multibed ward)
    Sign, "Isolation"
    Small table (or bedside cabinet)
    Basin stand, double[2]
    Washbasins, 2[2]
    Germicide solution[2]
    Paper towels
    Hand lotion
    Masks, disposable
    Gowns, clean
    Step-on can

is usually the method of transmission in venereal disease; indirect contact, in wound and skin infections.

(4) *Inoculation into the blood stream.* Insects or animals that bite infected persons can transmit pathogens that cause such diseases as malaria, tetanus, and rabies to well persons that they also bite. Disease organisms can also be transmitted from one person to another by contaminated needles and syringes—a major mode of transmitting a disease such as serum hepatitis. Furthermore, blood from a wound of an infected person can transmit disease organisms by coming into contact with open cuts or wounds on a well person.

b. Community Measures for Controlling Communicable Diseases.

(1) *Community sanitation.* The control of communicable diseases may require local, state, national, or international regulations. These regulations frequently involve the departments of preventive medicine and the public health service. One of the most important aspects of control of infectious diseases is the provision of a sanitary environment. This includes insect and rodent control; inspection of food, milk, and water; and garbage and sewage disposal. Other measures include immunization programs, premarital examinations to detect venereal diseases, and community surveys to detect pulmonary tuberculosis.

(2) *Education of the public.* Although reporting communicable diseases is the responsibility of the doctor, it is the responsibility of everyone to report to the doctor or the proper public health official anyone—particularly himself—he has reason to believe is suffering from an untreated communicable condition. It is also the responsibility of everyone to inform himself of the methods of transmission of communicable disease organisms so that he can take measures to protect himself and others from infection. Good personal hygiene, including body cleanliness, adequate rest, and a well-rounded diet, will go far to strengthen the body's defense against disease. Avoiding crowded areas during periods of epidemics will also help. Furthermore, to aid in preventing spread of communicable disease, each individual must cover his mouth and nose when coughing or sneezing, carefully dispose of all tissues containing nose and throat excretions, and always wash his hands after using the toilet.

c. Hospital Measures for Controlling the Spread of Communicable Diseases.

(1) *Medical asepsis.* Recent hospital experiences with the spread of staphylococcal infections within the hospital environment have resulted in renewed emphasis on the importance of applying basic principles of medical asepsis in all hospital areas for all patients. Essential measures previously discussed include handwashing between contacts with patients; disinfecting equipment and utensils in common use before storing or using for another person; handling and disposing of all wastes, soiled linen, etc., to prevent the

Table 5-5. Differentiation Between Medical and Surgical Aseptic Techniques

	Medical Aseptic Technique	Surgical Aseptic Technique
Definition	All of the procedures used to protect the patient and his environment from the spread of infectious organisms.	All of the procedures used to sterilize and to keep sterile any object or article that is to be introduced into a wound or body cavity or that is to penetrate the skin.
Emphasis	On cleanliness (freedom from pathogenic organisms).	On sterility (freedom from all organisms).
Purpose	To reduce the transmission of pathogenic organisms from one person to another.	To prevent introduction of any organism into an open wound or body cavity.
Isolation	Patient with a communicable disease is separated from rest of patients by room, ward, or unit.	Patient requiring surgery is taken to the OR, a separate department away from the rest of the hospital.
Zone	A zone about the isolation unit is established as contaminated. *NOTE.* Everything within the zone of isolation is contaminated. Nothing goes out of the zone without being disinfected or wrapped in a clean cover to permit handling in a clean zone.	A zone about the site of operation or wound is established as a sterile field. *NOTE.* Once a sterile article touches an unsterile article, it is contaminated (unsterile). Only sterile articles are brought into the sterile field.
Handwashing	Hands and forearms are washed for 1 to 2 minutes to remove surface contaminants and soil. Plenty of soap, water, and friction are used, rubbing well between fingers and around nails. Hands are held down under running water to drain off fingertips. Hands and arms are dried with paper towels.	Hands and forearms are scrubbed for 10 minutes to reduce the bacterial count on the skin surface. Plenty of soap, water, and friction are used, rubbing well between fingers and under nails. Hands are held up under running water to drain off elbows. Hands and arms are dried with a sterile towel.
Gowns	Clean gowns are worn to protect the worker. Inside of gown is clean; outside of gown in contact with patient and his environment is contaminated.	Sterile gowns are worn to protect the sterile field from the worker. Outside of gown in contact with sterile field must be kept sterile.

openings are to be packed with cotton in addition to external padding.

7. Prop sagging jaw with folded ABD pads.

CAUTION

Bandage ties may mar the face and, if used, must be padded well with absorbent cotton.

8. Pad ankles with cotton and tie together with bandage.
9. Tie one signed tag (DA Form 8-219) to right great toe. Tie second signed tag to left wrist.
10. Roll body gently to side of the bed. While assistant supports it, place one clean sheet diagonally under the body.
11. Roll body back to center of the sheet.
12. Fold upper corner of sheet loosely over the head and face with lower corner over the feet. Secure the arms at the side as the right and left corners of the sheet are brought over to complete the wrapping. Fasten sheet with safety pins.
13. Fasten third signed tag to outside of sheet. If dentures could not be replaced, wrap in gauze, identify, and pin dentures next to tag.
14. Lift wrapped body to stretcher, using the bottom sheet on the bed for lifting. Fasten litter straps at chest and just above the knees, avoiding any pressure. Cover body with sheet.
15. Before moving body from preparation room, obtain clinical records which are to accompany body to the morgue; notify morgue attendant by telephone; if elevator is to be used, signal for it and hold it at the required floor; close patient doors if necessary; and verify appropriate route to be used to avoid, if possible, public entrances and lobbies.
16. Transport the body quietly and with dignity to the morgue. Remain with the body until the laboratory attendant has received it and transferred it from the ward stretcher. Turn over records to the morgue attendant.
17. Return to the ward with the stretcher. Do terminal cleaning procedure of the patient's unit.

Section X. SPECIALIZED NURSING CARE AND RELATED PROCEDURE

5-92. Care of Patients With Communicable Diseases

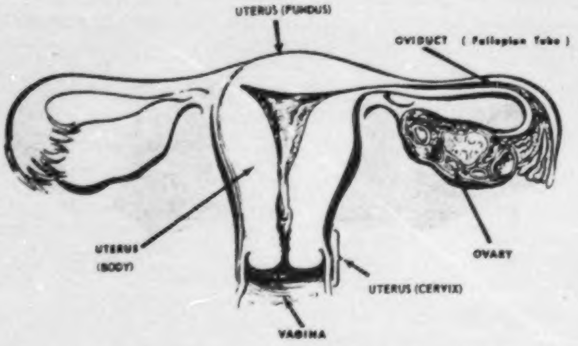
Communicable diseases are those which may be transmitted directly or indirectly from one person or animal to another. Direct transmission is by actual contact with the infected person or animal; indirect transmission is by contact with contaminated objects. Communicable disease microorganisms enter and leave the body through recognized portals of entry and exit; *for example,* the respiratory tract, gastrointestinal tract, and lesions of skin or mucous membrane. For additional discussion of causes and control of communicable disease, refer to FM 21-10.

a. Portals of Entry and Exit.

(1) *The respiratory tract.* The most common portal of entry and exit of microorganisms is the respiratory tract. Microorganisms leave the body of the infected person by means of droplets and by nose and throat secretions. Droplets, moist particles containing any pathogens present in the respiratory passages, are exhaled as a spray in coughing and sneezing and, to a lesser extent, in talking or just breathing. The droplet spray travels about 3 feet (more in a violent sneeze) from the source. Small residues (droplet nuclei) which result from evaporation of droplets remain suspended in the air of poorly ventilated enclosed spaces for relatively long periods of time and can be inhaled by a well person, who may then become infected with the disease. The infection may also be spread to a well person who improperly handles secretions of the patient's nose and throat or who inhales dust heavily contaminated with organisms.

(2) *The gastrointestinal tract.* Pathogenic organisms causing communicable diseases such as typhoid and dysentery are transmitted by the ingestion of food and water contaminated by feces. Such diseases result chiefly from poor hygiene and poor sanitation. The most common means of transmission can be summarized as the 5 F's: FECES, FINGERS, FLIES, FOOD, and FLUIDS.

(3) *Mucous membrane and skin.* Communicable disease organisms can leave the body of the infected person through exudates and secretions from infectious lesions and enter the body of the well person through cuts or small breaks in the mucous membrane and skin. *For example,* venereal disease (such as syphilis and gonorrhea), wound infections, and skin infections (such as impetigo) are spread in this manner. Direct contact



Internal Organs - Female Reproductive System

Figure 2-37. Female reproductive organs (frontal section).

ward over the bladder) (fig. 2-36). The uterus is about three inches long and three inches thick at its widest part. It has a thick wall of smooth muscle and a relatively small inner cavity. During pregnancy, it can increase about 20 times in size. The upper dome-shaped portion of the uterus is the fundus, the main part is the body, and the lower neck portion is the cervix (fig. 2-37). The cervix is a canal opening into the vagina. The inner lining of the uterus, the endometrium, undergoes periodic changes during the regular menstrual cycle, to make the uterus ready to receive a fertilized ovum. If the ovum is not fertilized, the endometrium gets a message from hormone influences and sheds its surface cells and built-up secretions. Some of the extra blood supply, the surface cells, and uterine secretions are eliminated as menstrual flow.

d. The Vagina. This muscular canal extends from the cervix of the uterus to the vaginal opening in the vestibule of the vulva. The vaginal canal is capable of stretching widely and serves as the birth canal. Part of the cervix protrudes into the uppermost portion of the vagina. An important part of a female pelvic examination is the physical examination of the visible surface of the cervix and vagina, plus a laboratory examination of cervical and vaginal secretions. A Pap (Papanicolaou) smear is made by obtaining these secretions for laboratory examination.

e. The Vulva. The several structures that make up the female external genitalia form the vulva. These are the mons pubis, the labia, the clitoris, and the vestibule. The labia, two parallel sets of liplike tissues, are the labia majora, the larger outer folds of tissue, and the labia minora, the smaller inner folds. The clitoris is located at the upper meeting point of the labia majora and the labia minora. Between the labia minora is the vestibule, a shallow depression into which the urethra and the vagina open. The urethral opening is above the vaginal opening. A series of glands, which can become infected, open into the vestibule, the largest being the Bartholin glands at the vaginal opening.

2-87. Menstruation

In preparing to receive the ovum, the mucous lining (mucosa) of the uterus becomes soft and swollen and uterine blood vessels are dilated. If the ovum is not fertilized, the unneeded blood and mucosa are expelled from the uterus through the vagina. This process, called menstruation, begins at puberty and is repeated, except when interrupted by disease or pregnancy, about every 28 days until the age of 40 to 50 years.

the normal menstrual cycle An ovum is expelled from the surface of an ovary in a process called ovulation, which occurs about halfway between each menstrual period. An expelled ovum is picked up by the free end of a fallopian tube for transportation to the uterus.

b. Fallopian Tubes. There are two fallopian tubes (oviducts) each curving outward from the upper part of the uterus. About four inches in length, each tube has a free end which curves around, but is not attached to, an ovary. The fringed surface of the free end of the fallopian tube carries an expelled ovum into the tube, and the ovum moves slowly on its way to the uterus. If fertilization takes place, it normally occurs as the ovum moves through a tube. The male germ cell, the sperm, must therefore travel up the female reproductive tract in order to unite with the female germ cell, the ovum. Of the millions of sperm produced, only one must unite with one ovum for fertilization to occur.

c. The Uterus. The uterus, shaped somewhat like a pear, is suspended in the pelvic cavity, supported between the bladder and the rectum by its system of eight ligaments. The normal position of the body of the uterus is anteflexion (bent for-

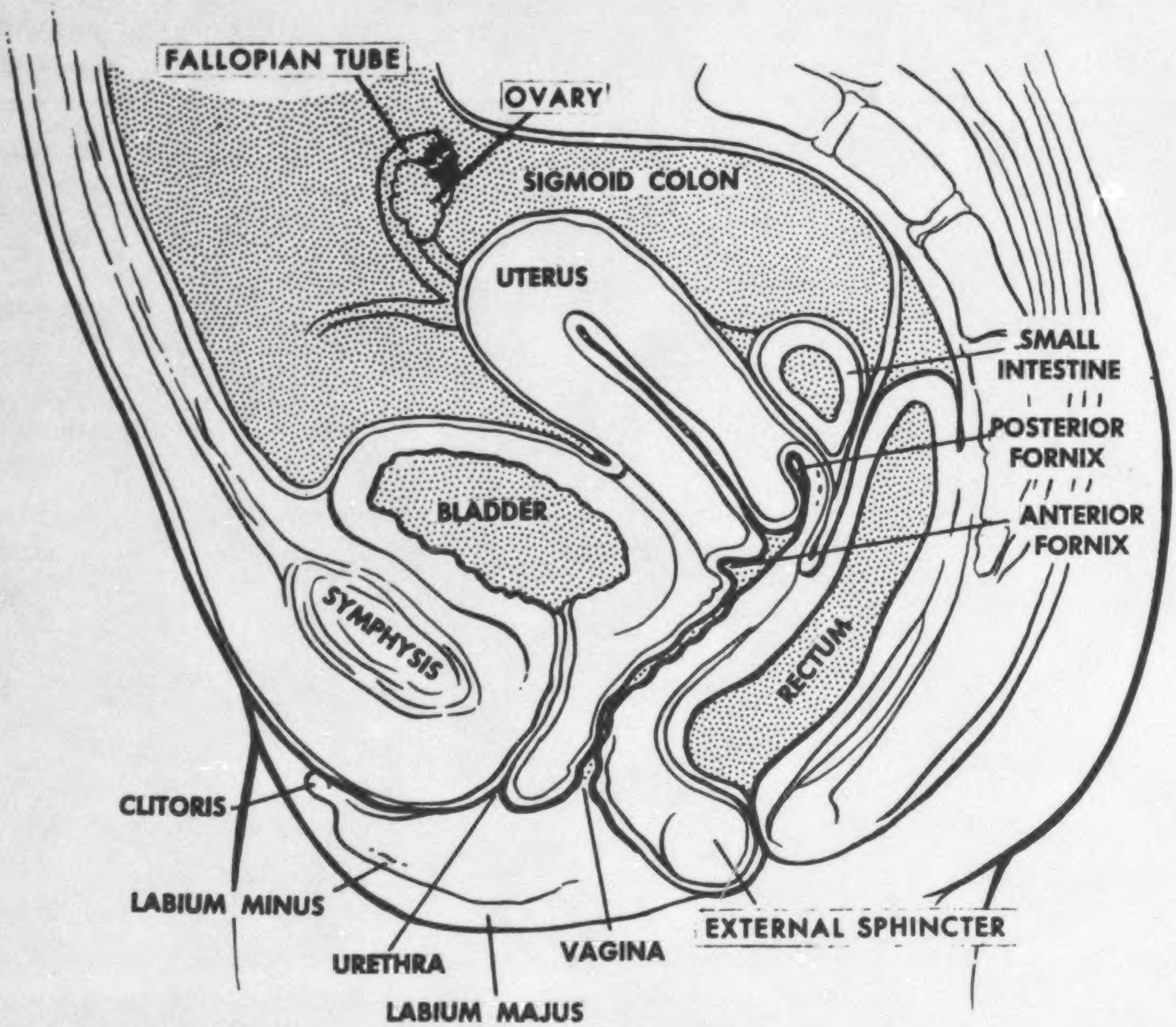

FALLOPIAN TUBE
OVARY
SIGMOID COLON
UTERUS
SMALL INTESTINE
POSTERIOR FORNIX
ANTERIOR FORNIX
BLADDER
SYMPHYSIS
RECTUM
CLITORIS
LABIUM MINUS
URETHRA
VAGINA
EXTERNAL SPHINCTER
LABIUM MAJUS

Figure 2–36. Female urogenital system.

Sperm travels from the testis to the tightly coiled tube, the epididymis. A continuation of the epididymis is the ductus deferens (or vas deferens) (fig. 2–35).

b. The Ductus Deferens. This duct carries sperm from the scrotum to the pelvic cavity. As the duct leaves the scrotum, it passes through the inguinal canal into the pelvic cavity as part of the spermatic cord. Spermatic cords, one in each groin, are supporting structures. Each ductus deferens curves around the bladder and delivers the sperm to one of two storage pouches, called the seminal vesicles.

c. The Seminal Vesicles and Ejaculatory Ducts. The seminal vesicles are located behind the bladder. During the storage of sperm in these vesicles, secretions are added to them to keep them alive and motile. The secretions and the sperm form the seminal fluid, or semen. Ejaculatory ducts carry the seminal fluid from the seminal vesicles, through the prostate gland, to the urethra.

d. The Prostate Gland. This gland is located around the urethra at the neck of the bladder (fig. 2–35). Prostatic secretions are added to the seminal fluid to protect it from urethral secretions and female vaginal secretions. When the prostate gland becomes enlarged (hypertrophied), it can seriously constrict the urethra. The size and consistency of the prostate gland is determined by the doctor by means of a rectal examination.

e. The Urethra and the Penis. The urethra, a passageway for seminal fluid and for urine, has its longest segment in the penis. Several glands add secretions to the urethra, the largest being two bulbo-urethral (or Cowper's) glands (fig. 2–35). The terminal opening of the urethra is in the glans penis, which is surrounded by a retractable fold of skin called the foreskin, or prepuce. Surgical removal of the foreskin is circumcision, which is performed to reduce the possibility of an abnormal constriction of the glans, called phimosis, or to reduce the possibility of irritation from secretions that accumulate under the foreskin. The penis has spongy tissues which become distended from a greatly increased blood supply during penile erection.

2–86. The Female Reproductive System

The major parts of the female reproductive system (fig. 2–36) are the ovaries; fallopian tubes; uterus; vagina; and the external genitalia, the vulva. The supportive structures for the internal reproductive organs are a complicated arrangement of pelvic ligaments, which are formed in part, from folds of peritoneum that line the abdomino-pelvic cavity.

a. The Ovaries. These are described as two almond-shaped glands (fig. 2–37), one on either side of the abdomino-pelvic cavity. They produce female germ cells, ova, and female hormones, estrogen and progesterone. These hormones maintain

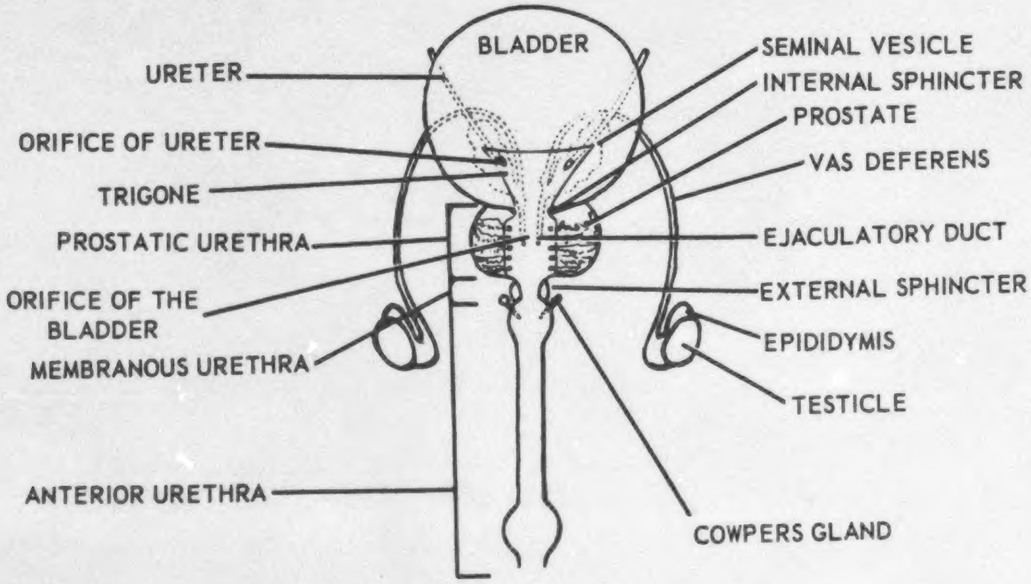


Figure 2–35. Diagram of male reproductive system.

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Section XII. THE REPRODUCTIVE SYSTEM

2–84. General

The male and female reproductive systems have their own specialized internal and external organs, passageways, and supportive structures. The parts and functions of these systems are designed to make the process of fertilization possible. The female cell, the ovum, must be fertilized by the male cell, the spermatozoa. The normal result of fertilization is reproduction. (Pregnancy and childbirth will be discussed in chapter 7.)

2–85. The Male Reproductive System

The major parts of the male reproductive system (fig. 2–34) are the scrotum, testis, epididymis, ductus deferens (also referred to as vas deferens or seminal duct), seminal vesicles, ejaculatory ducts, prostate gland, urethra, and penis. The penis, testes, and scrotum are referred to as external genitalia.

a. The Scrotum, the Testes, and the Epididymis. There are two testes, one on each side of the septum of the scrotum. A testis is an oval-shaped gland, about 1½ to 2 inches in length, which produces the male germ cells, spermatozoa (or sperm), and the male hormone, testosterone. Sperm are produced in great numbers, starting at the age of puberty. Although microscopic in size, each sperm has a head, which contains the cell nucleus, and an elongated tail for movement.

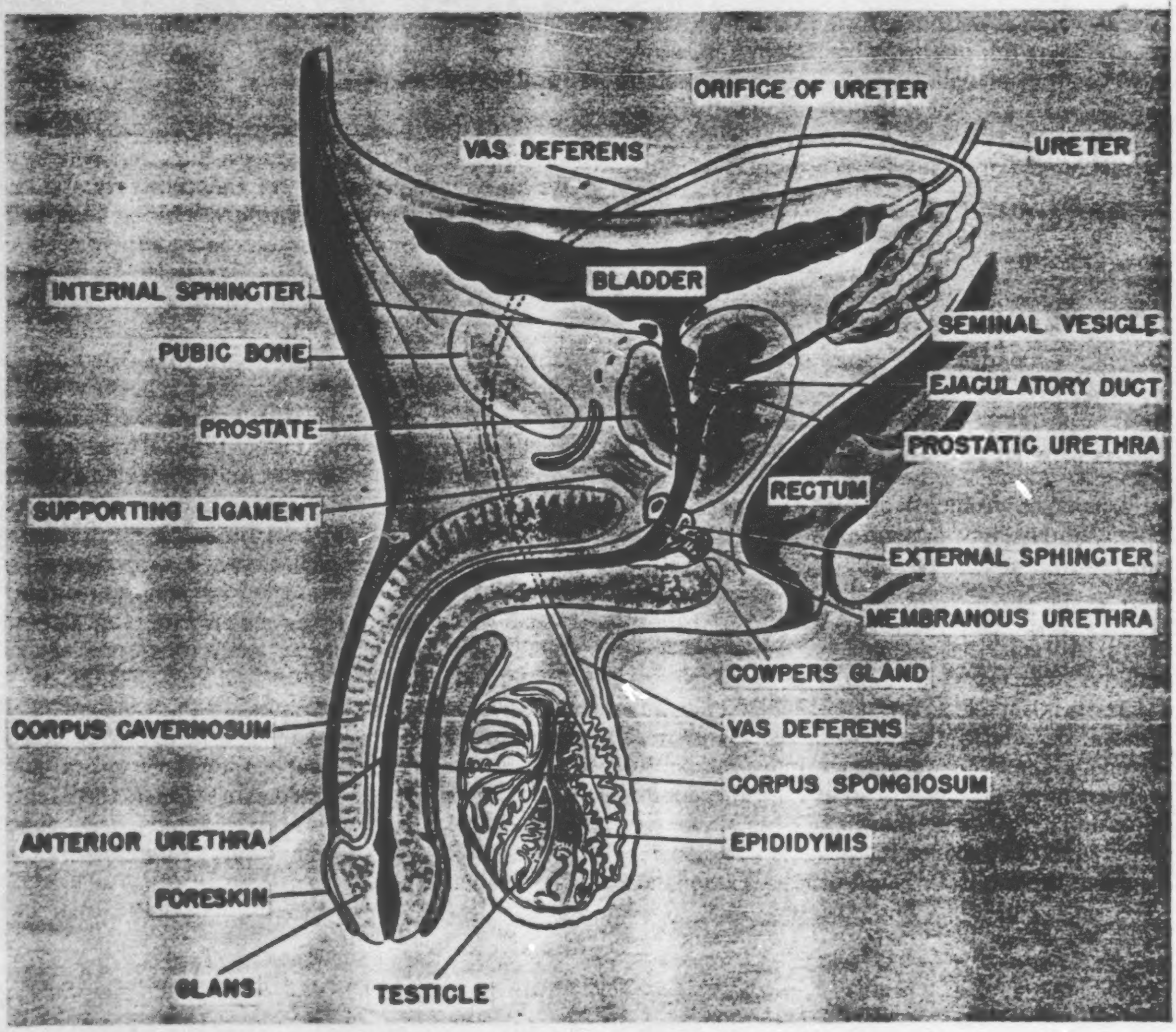

ORIFICE OF URETER
VAS DEFERENS
URETER
BLADDER
INTERNAL SPHINCTER
SEMINAL VESICLE
PUBIC BONE
EJACULATORY DUCT
PROSTATE
PROSTATIC URETHRA
RECTUM
SUPPORTING LIGAMENT
EXTERNAL SPHINCTER
MEMBRANOUS URETHRA
COWPERS GLAND
VAS DEFERENS
CORPUS CAVERNOSUM
CORPUS SPONGIOSUM
EPIDIDYMIS
ANTERIOR URETHRA
FORESKIN
GLANS
TESTICLE

Figure 2–34. Male urogenital system.

servation for tetany may be required in the immediate postoperative period following thyroid surgery. Calcium is given by intravenous infusion to relieve the symptoms of tetany.

2–80. The Adrenal Glands

The two adrenal glands are located one above each kidney (suprarenal glands). Each adrenal gland actually functions as two separate glands, producing different hormones from its two parts, the medulla and the cortex. The medulla is the inner part of the adrenal gland. It produces epinephrine, the "fight or flight" hormone. The medulla is stimulated to produce epinephrine by the sympathetic branch of the autonomic nervous system in order to give the body the extra push it needs in responding to emergencies. The cortex, the outer part of the adrenal glands, produces a series of adrenocortical hormones, which include hydrocortisone. The adrenocortical hormones influence the salt and water balance of the body, the metabolism of foods, and the ability of the body to handle stress. The cortex of the adrenal glands requires stimulation by a hormone produced by the pituitary gland.

2–81. The Pituitary Gland

The pituitary gland, located deep within the skull, is also called the hypophysis. This small gland has two lobes, each producing distinctive hormones. The anterior lobe hormones stimulate other endocrine glands to produce their distinctive secretions; for this reason, the pituitary gland is called the master gland of the endocrine system. The four hormones produced by the anterior lobe of the pituitary have names with the suffix "trophic," meaning nourishing. Somatotrophic hormone (STH) means body nourishing. This hormone influences skeletal and soft tissue growth. Adrenocorticotrophic hormone (ACTH) stimulates the cortex of the adrenal gland to produce its cortisone-type hormones. Gonadotrophic hormone stimulates the normal development of the gonads, the testes or ovaries, and controls the development of the male and female reproductive systems. Thyrotrophic hormone stimulates the thyroid gland to produce its hormone. The posterior lobe of the pituitary gland produces a hormone that stimulates the contraction of the smooth muscle of the uterus, so it is important in childbirth. Another posterior lobe hormone which helps prevent excessive water excretion from the kidneys is called the antidiuretic hormone.

2–82. The Testes and Ovaries (the Gonads)

The male testes are located in the scrotum; the female ovaries, in the lower abdominal cavity. Hormones produced by these glands stimulate the development of sexual characteristics that normally appear at the development period called puberty (sexual maturity). They are responsible for the appearance of the secondary sexual characteristics: the pubic and axillary hair, the beard and the changing of the voice, and mammary (breast) development in the female. These hormones also help maintain the reproductive system organs in their adult state.

2–83. The Pancreas

Part of the pancreas functions as an accessory organ of the digestive system and part functions as an endocrine gland. Its endocrine gland function is carried out by groups of pancreas cells called the islands of Langerhans, which produce the hormone insulin. This hormone is necessary for the normal use of sugar by body cells. If insulin is not produced in sufficient amounts, the sugar normally present in the blood cannot be properly used by body cells, and the disease, diabetes mellitus, develops. A patient with diabetes mellitus requires continuous medical treatment—a combination of diet modification, education in modified living habits, and special medication as needed. As a medication, insulin must be given by hypodermic injection, because it is destroyed by digestive juices when taken by mouth. However, some patients requiring medication for diabetes mellitus can be treated with oral medications which are NOT insulin but which apparently stimulate underfunctioning pancreatic cells to produce insulin. An example of such a medication is tolbutamide (orinase). Other types of oral medication (such as phenformin) for diabetes promote the utilization of glucose by muscle tissue instead of stimulating underfunctioning pancreatic cells.

The receptor for hearing, the organ of Corti, lies within a structure called the cochlea which is coiled and resembles the shell of a snail.

(1) Sound waves, which pass through the external auditory canal, vibrate the eardrum and ossicles and are finally transmitted through the fluid of the inner ear. Nerve impulses travel through the acoustic (auditory) nerve from the organ of Corti to the auditory center of the cerebral cortex. The acoustic nerve is the final link in the chain of mechanisms which convey the sensation of sound to the brain for perception.

(2) The internal ear also contains three semicircular canals which control equilibrium. Change in the position of the head causes movement of the fluid within the canals and this fluid movement stimulates nerve endings in the wall of the canal. These nerve endings serve as receptors and transmit impulses along the acoustic nerve to the cerebellum.

Section XI. THE ENDOCRINE SYSTEM

2-77. Components

The endocrine system is made up of glands classified as glands of internal secretion (ductless glands). These glands are located in different parts of the body (fig. 2-33). Secretions produced by endocrine glands are hormones, which are secreted directly into the circulating blood, reach every part of the body, and influence the activities of specific organs and tissues, as well as the activities of the body as a whole. Small in quantity but powerful in action, hormones are part of the body's chemical coordinating and regulating system. There are six recognized endocrine glands—the thyroid, parathyroid, adrenals, pituitary (hypophysis), the testes or ovaries (male or female gonads, the glands of sex), and the pancreas.

2-78. The Thyroid

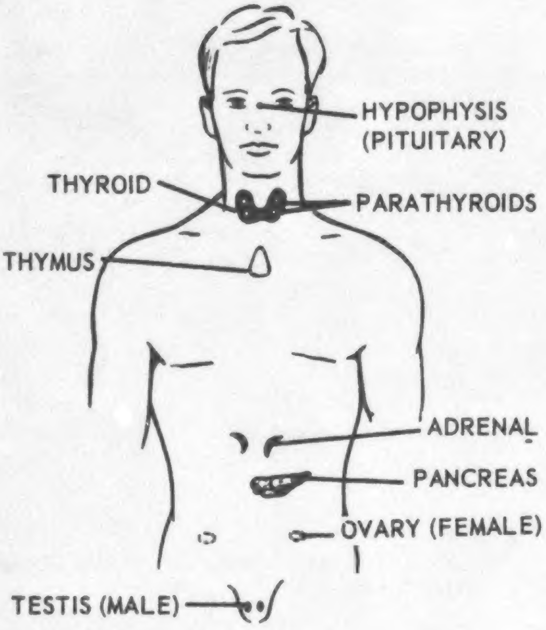
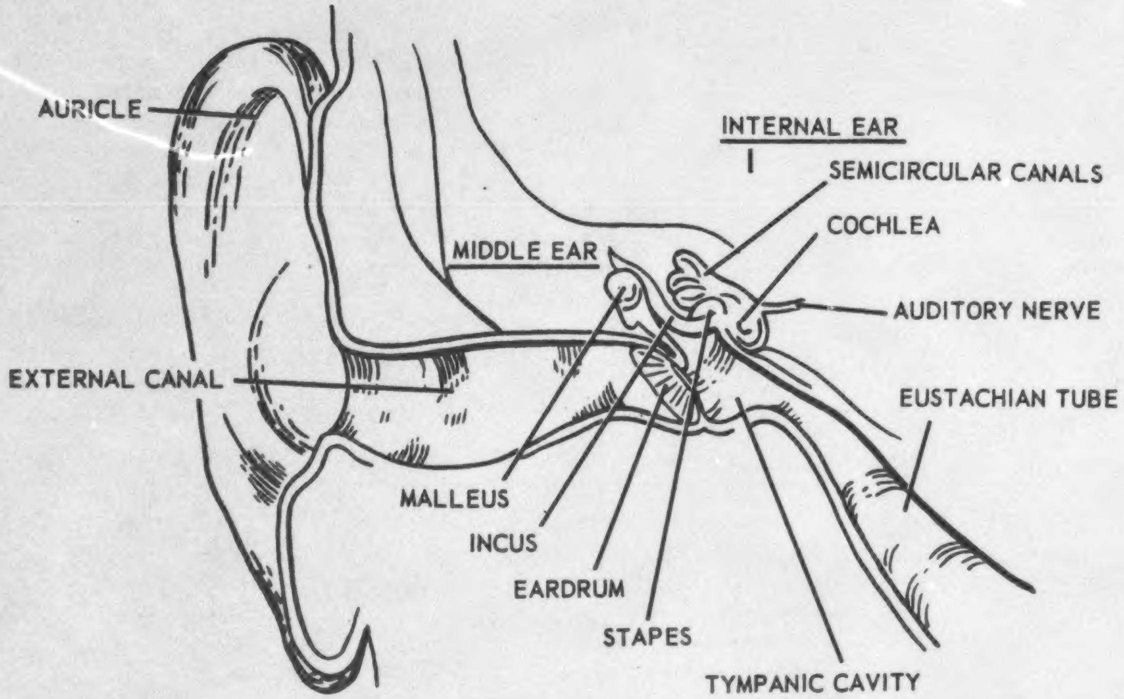


Figure 2-33. Endocrine system.

The thyroid gland, located in front of the neck, has two lobes, one on either side of the larynx. The hormone produced by the thyroid is thyroxin. This hormone is associated with metabolism, regulating heat and energy production in body cells. Thyroid gland cells need a mineral, iodine, to manufacture thyroxin. Iodine is ordinarily obtained from foods included in normal diet; however, certain geographical areas have an iodine deficiency. In these areas, iodized table salt can be used to insure an adequate amount of iodine for normal thyroid function. (This use of iodized salt is an example of a preventive health measure.) Disorders of thyroid function include hyperthyroidism, which, when severe, causes a dangerous increase in the metabolic rate; and hypothyroidism, an opposite condition, which causes physical and mental sluggishness. An enlargement of the thyroid gland is called a goiter. When the enlargement is a nodular tumor, it is called an adenoma. During a physical examination, the doctor may palpate the neck tissues to determine the size and consistency of thyroid tissue.

2-79. The Parathyroids

The parathyroid glands, usually four in number, are located on the posterior surfaces of the lobes of the thyroid gland. These glands produce the hormone, parathormone, which helps to regulate the amount of calcium in the blood. Calcium, normally stored in the bones, is released into the blood as required for normal nerve and muscle tissue function. When there is too little calcium in the blood, a type of muscle twitching called tetany develops. Because of the location of the parathyroid glands in relation to the thyroid, special ob-



b THE EXTERNAL, MIDDLE, AND INTERNAL EAR, FRONTAL VIEW

Figure 2-32—Continued

the anterior wall of the cartilaginous portion of the canal and are filled with fibrous membrane which allows for the flexibility of the canal. If the auricle (helix area) is pulled up and back, this portion of the canal straightens and may be examined or treated more easily. The entire passage is lined with skin. Near the entrance of the canal, the skin contains wax-producing glands and hair follicles. This wax, called cerumen, also helps to prevent the entry of foreign objects into the ear.

(2) The tympanic membrane, or eardrum, separates the inner end of the canal from the middle ear. The medical officer examines the external canal and the eardrum by means of a lighted instrument, an otoscope. The normal eardrum is translucent (partly transparent) and shiny gray (pearl-like). When inflamed, it appears pink or dull red.

c. The middle ear (tympanic cavity) is an irregular space in the temporal bone filled with air and containing the three ossicles of the ear: malleus (hammer), incus (anvil), and stapes (stirrup). These bones conduct vibrations from the eardrum to the internal ear.

(1) The eustachian tube which connects the middle ear with the nasopharynx is about 1½ inches long. The trumpet-shaped opening of the eustachian tube into the pharynx remains closed except during the act of yawning or of swallowing, when it opens to admit air into the middle ear, thus performing its principal function of keeping the air pressure equal on either side of the eardrum. This is also an avenue of infection by which disease spreads from the throat to the middle ear.

(2) The roof or superior wall of the middle ear is composed of a very thin plate of bone which separates it from the dura. This bony plate is quite susceptible to fracture in head trauma and to spread of infection from the middle ear (otitis media), either of which can result in intracranial disease.

d. Internal ear (labyrinth). The internal ear contains receptors for hearing and equilibrium.

the iris. The semitransparent conjunctiva appears while on the front surface of the eyeball where it covers the sclera and pink where it overlies lid tissue. Should the conjunctiva itself become inflamed or infected it appears red and swollen; one type of acute bacterial infection of the conjunctiva is commonly called "pinkeye."

(4) *The lacrimal apparatus.* The lacrimal apparatus consists of the lacrimal gland, lacrimal ducts (canaliculi), lacrimal sac, and the nasolacrimal duct (fig. 2–31 Ⓑ). Its function is the secretion and drainage of tears. The lacrimal gland (not illustrated) is about the shape and size of a small almond and is located in a small depression on the lateral side of the frontal bone of the orbit. Many small ducts drain tears secreted by the gland to the conjunctival surface; the tears drain downward and toward the inner angle of the eye. The normal regular blinking of the eyelids helps to spread the tears evenly to provide a lubricating, protective, moist film over the exposed surface of the cornea. The tears drain into openings near the nasal portion of each eyelid (lacrimal puncti) and then into the tear ducts, the sac, and finally into the nose through the nasolacrimal duct. This normal formation and drainage of tears is the natural way in which the eye surface is kept clean and moist.

(5) *Extraocular muscles.* In addition to the levator muscles of the eyelids and the orbicularis oculi, there are six sets of muscles located outside the eyeball. These muscles raise, lower, or rotate the eyeball within its socket. The muscles of the two eyes normally function in a coordinated manner so that both eyes move simultaneously and are aimed in the same direction. Divergence or crossing of the eyes is called strabismus.

2–76. The Ear

The ear, the organ of hearing, consists of three parts; the external ear, the middle ear (tympanic cavity), and the internal ear (the labyrinth). These divisions are commonly referred to as the outer ear, the middle ear, and the inner ear. They provide the reception and conduction of sound and contain one of the principal mechanisms for the maintenance of equilibrium. The structures of the ear, except the part protruding from the head, are situated within portions of the temporal bone of the skull.

a. The external ear (fig. 2–32 Ⓐ) consists of the shell-shaped portion of the ear, called the auricle or pinna, which projects from the side of the head and of the external acoustic meatus, which is the external auditory canal leading inward toward the middle ear. The principal function of the external ear is the collection and conduction of sound waves to the middle and the inner ear. The auricle or pinna is composed of cartilage covered with membrane (called the perichondrium) and the skin.

(1) The prominent folded rim of the ear is the helix.

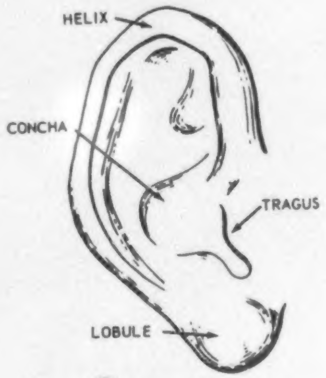
(2) A deep cavity, the concha, leads into the external auditory canal.

(3) In front of the concha and projecting backward over the entrance to the external auditory canal is a small, triangular eminence of cartilage called the tragus. The tragus protects, but does not touch, the entrance to the external auditory canal. The undersurface of the tragus is usually covered with soft hairs which help to prevent insects and other foreign bodies from entering the ear.

(4) The lobule, or lobe, is located inferior to the tragus and to the lowest point of the helix. The lobule contains no cartilage, is composed of adipose (fatty) tissue and of connective tissue, and lacks the firmness of the rest of the auricle.

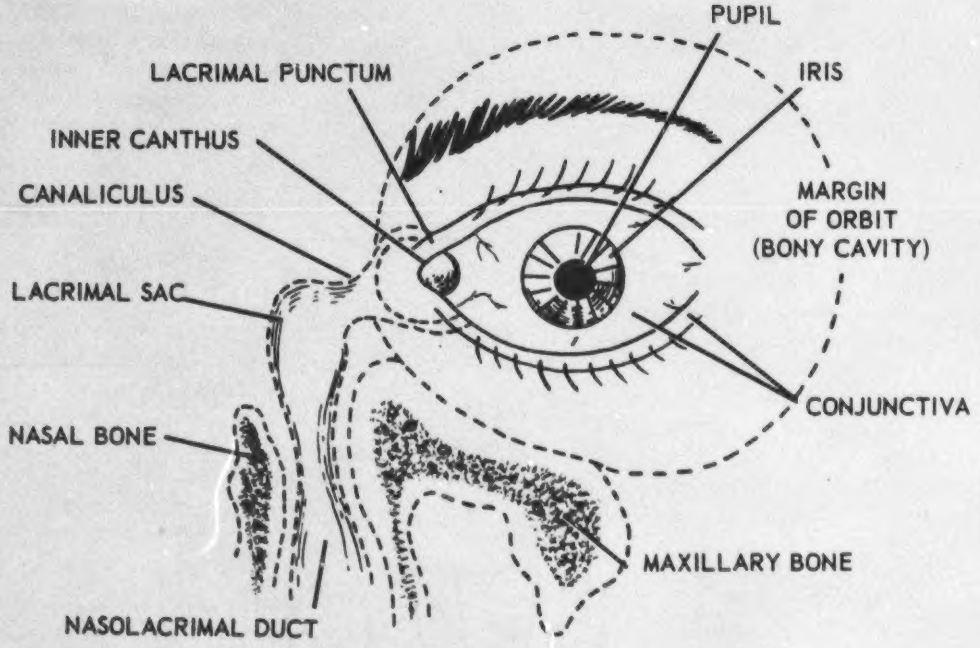
b. The external auditory canal extends about 1¼ inches from its entrance at the bottom of the concha to the tympanic membrane, or eardrum, which closes its inner end. The canal is formed of two parts, its outer, or cartilaginous, part which is formed of cartilage and membrane; and its inner, or bony portion, formed by a passage in the temporal bone. The cartilage of the auricle is continuous with that forming the outer portion of the canal.

(1) Two or more deep fissures are present in



Ⓐ THE AURICLE

Figure 2–32. The ear.



Ⓑ THE EYE (FRONTAL, EXTERIOR VIEW, AND LACRIMAL APPARATUS.

Figure 2–31—Continued.

Aqueous fluid is normally crystal clear for transmission of light rays and its formation and flow helps maintain the normal intraocular pressure. The aqueous fluid flows from the posterior chamber to the anterior chamber and drains by means of a series of channels into the venous blood. The largest of these drainage channels is the canal of Schlemm. Interference with the normal formation and flow of aqueous fluid can lead to development of excessively high intraocular pressure, a condition called glaucoma. Glaucoma will cause blindness. Fortunately, glaucoma can be detected by a tonometry examination, the measurement of internal eye pressure by means of a measuring instrument, a tonometer. With early detection, glaucoma can be treated successfully and blindness can be prevented.

b. The External Eye and Accessory Structures. Viewed from the surface of the body, the anterior surface of the eye and some of its accessory structures such as eyebrows, lids, lashes, and conjunctiva are readily visible. An additional essential accessory structure, the lacrimal (tear) apparatus, is indicated in figure 2–31 Ⓑ.

(1) *Eyebrows and eyelashes.* The eyebrow and lashes are usually considered to have a cosmetic (decorative) function, but the eyelashes also help protect against the entrance of foreign objects into the eyes. An eyelash becomes a foreign body itself if it becomes detached and falls on the eye surface. On the margin of the eyelids near the attachment of the eyelashes are the openings of a number of glands. Infection in these glands is commonly called a sty.

(2) *Eyelids.* The eyelids are thin, moveable, protective coverings for the eyes. The junctions of the upper and lower eyelids of each eye are canthi; the inner canthus (fig. 2–31 Ⓑ) is at the nasal junction and the outer canthus is at the temporal junction. A sheet of connective tissue called the tarsal plate maintains the shape of the eyelids. The tarsal plate and the orbicularis oculi muscle hold the eyelids in proper position against the eye; a levator (lifting) muscle opens the upper lid by pulling the lid upward into the orbit. The circular orbicularis oculi muscle closes the eyelids.

(3) *Conjunctiva.* The conjunctiva (fig. 2–31 Ⓑ) is a delicate mucous membrane which lines the inside of the eyelids and covers the front surface of the eyeball, continuing over the cornea as the corneal epithelium. The edge or margin where the conjunctiva overlaps the cornea is called the limbus; it is sometimes visible at the periphery of

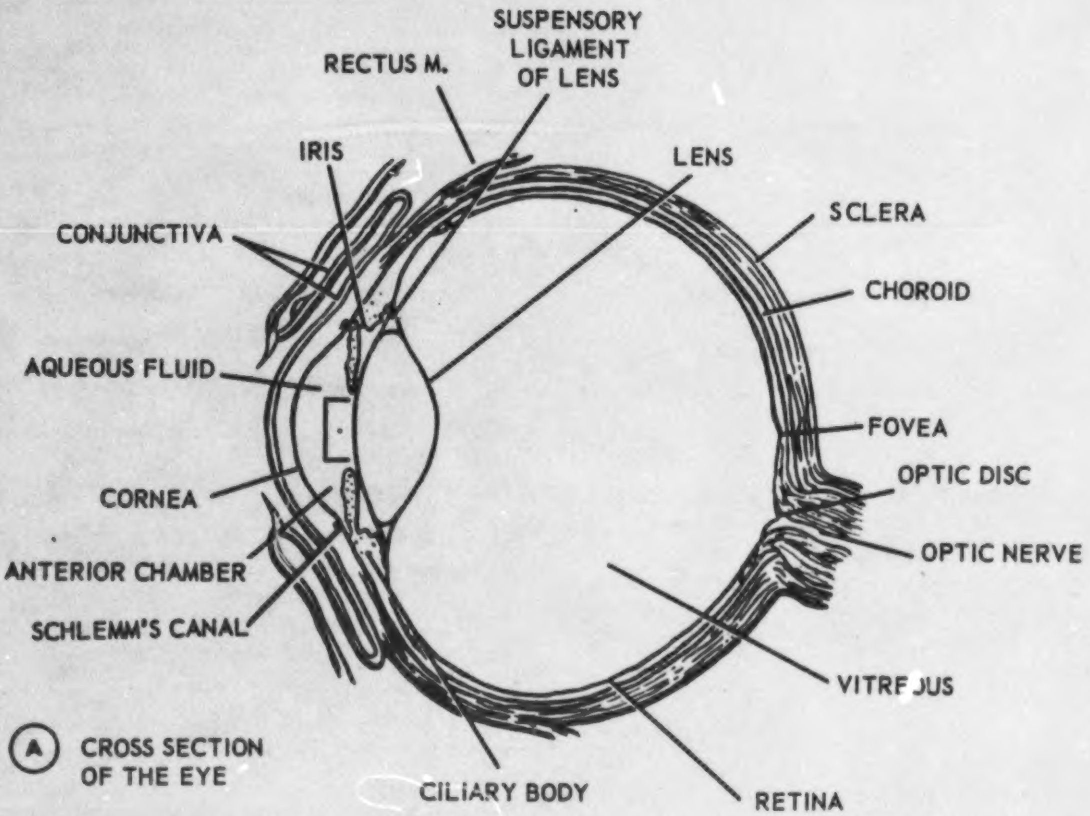


Figure 2-31. The eye.

the cornea and the lens. The pigment material in the iris gives the eye its characteristic color. The round opening in its center is the pupil. The muscle structure of the iris adjusts the size of the pupil to adapt the eye to existing brightness of light. The ciliary body lies between the iris and choroid; it has a muscular function, changing the focus of the lens, and a secretory function, producing aqueous fluid.

(*c*) *Inner coat.* The inner coat is the retina, which lines the interior of the eye except toward its anterior inner surface. The visual nerve cells (rods and cones) are arranged closest together at the central portion of the retina, the macula lutea. A slight depression in the macula lutea, the fovea centralis, is in a direct line back from the center of the cornea and lens and is the area of the retina most sensitive to light. Medial to the fovea centralis is the area called the optic disc, the site of exit of the optic nerve and entry of the retinal artery. Here there is a natural defect in the retina; there are no visual cells at the exit of the optic nerve and in every eye there is, therefore, a physiological "blind spot." When the doctor examines the interior of the eye with an ophthalmoscope, he can see the posterior surface of the retina and examine the appearance of the optic disc. The inner surface of the retina is in contact with the vitreous and the outer surface with the choroid. The condition known as "detached retina" means that some portion of the retina has become separated from the supporting choroid.

(2) *The lens.* The lens is a small, disc-shaped, transparent structure about ⅓ inch in diameter. It is situated immediately behind the iris and in front of the vitreous cavity. The lens is suspended in a capsule within the globe of the eye by a circular ligament, the suspensory ligament of the lens. This ligament is attached to the ciliary body. Muscular movements of the ciliary body affect the suspensory ligament and the consequent focus of the lens. The condition of "cataract" means that some portion of the lens has lost its transparency and has become cloudy or opaque.

(3) *Aqueous fluid.* The aqueous fluid is formed by a portion of the ciliary body and fills the two divisions of the anterior cavity of the eye, called the anterior and the posterior chamber.

Table 2-4. Functions of the Autonomic Nervous System

Increased sympathetic tone results in—	Increased parasympathetic tone results in—
1. Dilation of pupils.	1. Contraction of pupils.
2. Decreased tones of ciliary muscles, so that the eyes are accommodated to see distant objects.	2. Contraction of ciliary muscles, so that the eyes are accommodated to see objects near at hand.
3. Dilation of bronchial tubes.	3. Contraction of bronchial tubes.
4. Quickened and strengthened heart action.	4. Slowed heart action.
5. Contraction of blood vessels of the skin and viscera so that more blood goes to the muscles where it is needed for "fight or flight."	5. Dilation of blood vessels.
6. Relaxation of gastrointestinal tract and bladder.	6. Increased contractions of gastrointestinal tract and muscle tone of bladder.
7. Decreased secretions of glands (except sweat glands which secrete more).	7. Increased secretions of glands (except sweat glands).
8. Contraction of sphincters which prevents emptying of bowels and bladder.	8. Relaxation of sphincters which allows emptying of bowels or bladder.

transmitted by the olfactory nerve to the temporal lobe of the brain. Although olfactory receptor cells are quite sensitive, they can also become fatigued, and odors that at first may be very noticeable may be less so upon continued exposure. Smell is considered a primitive sense and the detection of odors is more highly developed in animals than in man.

b. Taste. Sense organs for taste are taste buds located in the surface of the tongue. The primary taste sensations are sweet, sour, salty and bitter. The actual sensation of taste, particularly for distinctive flavors, is influenced by the sense of smell. Taste sensation is usually dulled when nasal membranes are congested or when the nostrils are pinched shut while eating foods. Impulses from taste receptors are transmitted by nerve fibers from two cranial nerves, facial and glossopharyngeal, to the temporal lobe.

c. Sight. Cells in the retina of the eye (fig. 2-3 Ⓐ) are stimulated by light rays entering the eye. These stimuli create impulses that are carried by the optic nerve to the visual center of the occipital lobe of the brain.

d. Hearing. Cells in the cochlea of the inner ear (fig. 2-32 Ⓑ) are stimulated by vibration of sound waves. These stimuli create impulses that are carried by the cochlear branch of the acoustic (auditory) nerve to the auditory center of the temporal lobe.

e. Equilibrium. In addition to receptors for hearing, the internal ear contains three semicircular canals which regulate the sense of equilibrium. Change in position of the head causes movement of fluid within the canals. The fluid movement stimulates nerve endings in the walls of the canals which send impulses to the brain by the vestibular branch of the auditory nerve.

2-75. The Eye

The eye is specialized for the reception of light. Each eye is located in a bony socket or cavity called the orbit, which is formed by several bones in the skull. The orbit provides protection, support, and attachment for the eye and its muscles, nerves, and blood vessels.

a. The Eyeball. The interior of the eye (fig. 2-31 Ⓐ) is divided into an anterior cavity (anterior to the lens) and a posterior cavity (posterior to the lens). A clear watery solution, the aqueous fluid, is formed and circulated in the anterior cavity. A transparent, semifluid material, the vitreous fluid, is contained in the posterior cavity. The globular form and firmness of the eyeball is maintained by its fluid contents, which also function in the transmission of light.

(1) *Eye tissue coats.* The eyeball has an outer coat, a middle coat, and an inner coat.

(*a*) *Outer coat.* The outer coat consists of a normally invisible, transparent anterior portion, the cornea, and a fibrous, white, nontransparent portion, the sclera, which is directly continuous with the cornea. The transparent cornea focuses and transmits light to the interior of the eye. The surface of the cornea must be moist at all times to maintain its transparency. The sclera helps to maintain the shape of the eyeball and protects the delicate structures within.

(*b*) *Middle coat.* The middle coat consists of the choroid, the iris, and the ciliary body. These three structures are referred to as the uveal tract. The choroid, the vascular middle layer of the eyeball, lies beneath the sclera and lines the posterior portion of the eye from the ciliary body to the optic nerve. The iris is a circular, colored, muscular membrane which is suspended between stretching of the brachial plexus can cause paralysis of the arm and hand. If an unconscious patient's arm is allowed to dangle off a litter or bed, the plexus can be overstretched. Pressure from a plaster cast can also damage this area. The sacral plexus in the pelvic cavity supplies nerves to the lower extremity. The largest nerve in the body, the sciatic nerve, emerges from the sacral plexus. From the buttocks, the sciatic nerve runs down the back of the thigh; its branches supply posterior thigh muscles, leg, and foot. The sciatic nerve must be avoided when intramuscular injections are given into the buttocks.

(2) *Nerve fibers.* All spinal nerves carry both sensory and motor fibers. Some of the fibers supply skeletal muscle and others supply visceral (smooth) muscle. The spinal nerves are two-way conductors, and if anything happens to them, there can be both anesthesia, loss of sensation, and paralysis, loss of motion.

2–73. The Autonomic Nervous System

The autonomic nervous system is part of the nervous system that sends nerve fibers from nerve centers to smooth muscle, cardiac muscle, and gland tissue. Autonomic nerve fibers supply nerve impulses to body structures that are thought of as operating outside conscious control. Organs supplied are the heart, blood vessels, iris and ciliary muscles of the eye, bronchial tubes, parts of the esophagus, and abdominal organs. The autonomic nervous system is a part of the central and peripheral nervous system. It is not separate and independent. It has two divisions, sympathetic and parasympathetic. These divisions receive impulses from the CNS by way of the ganglia.

a. Ganglia are the relay stations of the autonomic nervous system. Neurons originating in the cord, or in the brain, conduct impulses to an autonomic ganglion. Other neurons conduct impulses from the ganglion to the tissue or organ. Ganglia of the sympathetic division are in a chain formation, like a string of beads, one on each side of the spinal column. Ganglia of the parasympathetic division are located in or near the organs to which they send impulses (table 2–4).

b. The sympathetic division regulates activities to prepare the body for maximum effort as a response to hazardous conditions. Sympathetic stimulation and response to stress go together.

c. The parasympathetic division regulates activities to conserve energy and to promote digestion and elimination.

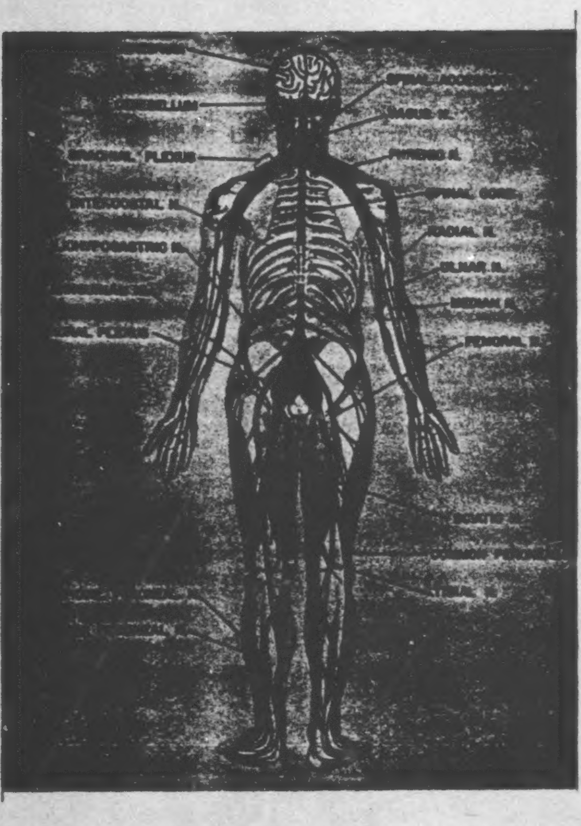


Figure 2–30. Principal nerve trunks.

2–74. Special Senses

Sensations of smell, taste, sight, hearing, and equilibrium are usually referred to as special senses because these sensations are received through specialized sense organs or receptors which are sensitive to specific types of stimuli. Other very important sensations such as touch, pressure, pain, heat, and cold are received through receptors widely distributed in the skin and underlying tissue and in viscera. Impulses from receptors for both special and other senses are carried by sensory nerve pathways to the cerebrum. There the impulses are converted into sensation and perception (awareness or consciousness of sensation). The parts of the sensory mechanism are (1) the sense organ or receptor, (2) the pathway by which the impulse is conducted into the central nervous system, and (3) the sensory center in the cerebrum. The sensory mechanisms of the special senses are summarized as follows:

a. Smell. Cells located in the olfactory membrane of the nose are stimulated by odors. The olfactory membrane is located in the uppermost part of the nose, in the area above the upper turbinates. Impulses from receptors for odors are pressure can be relieved by surgical procedures or by traction, permanent damage may be avoided. Careful and knowledgeable moving and transporting of all patients suspected of having a spinal injury is essential to minimize injury to the spinal cord. If the cord is severed, or if all cord tracts have been damaged, patients lose feeling because sensory impulses cannot reach the brain; they are paralyzed, because motor impulses from the brain can no longer reach muscles located below the injury. Damage to the cord in the cervical area is particularly disabling because all of the cord tracts below the injury are involved. Disease, injury, or chemicals (drugs) can cause loss of function by interrupting the conduction and connection pathways.

(4) All sensory impulses coming into the cord do not have to travel all the way to the brain to get a motor impulse reaction. The gray matter in the spinal cord contains reflex centers, the places where incoming sensory impulses become outgoing motor impulses. There are reflex centers in both the brain and the spinal cord. The knee jerk is an example of a spinal cord reflex. When the doctor taps the patellar tendon, the sensation is transmitted to a segment of the spinal cord at the lumbar level, and a motor impulse causes extension of the lower leg. This kind of reflex is an involuntary response. If lumbar segments of the cord are damaged, the knee jerk is absent. The doctor tests for these different reflexes during a neurological examination because in certain diseases they deviate from normal.

2-72. The Peripheral Nervous System

The peripheral nervous system is composed of the nerves located outside the brain and spinal cord. Cranial nerves and their branches stem from the brain; spinal nerves and their branches stem from the spinal cord.

a. The Cranial Nerves. The 12 pairs of cranial nerves arise from the undersurface of the brain and pass through openings in the skull to their destinations (table 2-3). The nerves are numbered and have names that describe their distribution or their function; *for example,* the vagus nerve (fig. 2-30), the cranial nerve, is an important nerve in the autonomic nervous system, with both sensory and motor fibers distributed to organs in the thorax and abdomen. The cranial nerves supply organs of special sense, such as the eye, nose, ears, tongue, and their associated muscles, and also control muscles of the face, neck, thorax, and abdomen.

NOTE

Cranial nerves are usually indicated by Roman numerals.

b. The Spinal Nerves. The 31 pairs of spinal nerves arise from the spinal cord and pass through lateral openings between the vertebrae. Spinal nerves are numbered according to the level of the spinal column at which they emerge. The lumbar, sacral, and coccygeal nerves descend from the terminal end of the spinal cord and emerge in sequence from their respective vertebrae. These lower spinal nerves form the cauda equina (horse's tail) within the spinal cavity. Spinal nerves branch and subdivide into many lesser nerves after emerging from the spinal cavity.

(1) *Nerve plexuses.* A nerve plexus is a network of spinal nerve subdivisions that appear as tangled masses in areas outside the spinal cord. The brachial plexus (fig. 2-30) is in the shoulder region. Nerves emerging from this tangle go to the skin, the arm, and the hand. Pressure and/or

Table 2-3. The 12 Cranial Nerves

Number and name	Origin	Associated with—
I. Olfactory (sensory)	Nasal chamber	Sense of smell
II. Optic (sensory)	Retina	Sense of sight
III. Oculomotor (motor)	Midbrain	Eyeball muscles
IV. Trochlear (motor)	Midbrain	Eyeball muscles
V. Trigeminal (sensory and mixed).	Pons	(Three branches) eye, upper portion of face, ear, lower lip, teeth, gums.
VI. Abducens (motor)	Pons	Eyeball muscles
VII. Facial (mixed)	Pons	Facial muscles, middle ear, taste
VIII. Auditory (sensory)	Pons	Sense of hearing and balance
XI. Glossopharyngeal (mixed)	Medulla	Taste, swallowing
X. Vagus (mixed)	Medulla	Swallowing, hunger, speech muscles, breathing, heart rate, peristalsis, control of glands in stomach and pancreas.
XI. Spinal accessory (motor)	Medulla	Muscles of neck and upper back.
XII. Hypoglossal (motor)	Medulla	Muscles of tongue

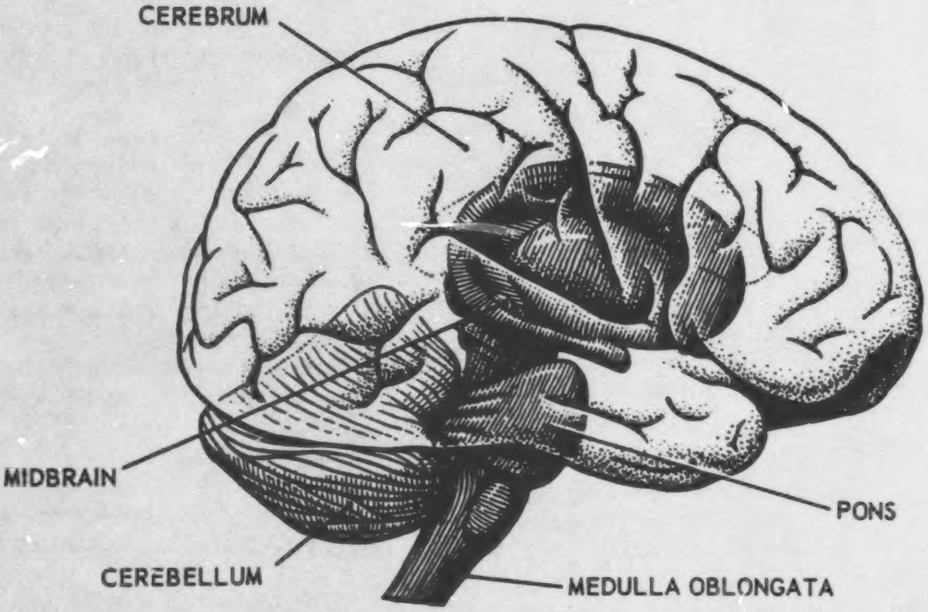


Figure 2-29. The brain, sagittal section.

coordinates with the cerebrum to produce skilled movements. The cerebellum helps control posture and controls skeletal muscles to maintain equilibrium. If the cerebellum is injured, movements will be jerky and trembly.

(3) *The pons.* The pons is a bridgelike structure, forming the part of the brain stem above the medulla. Nerve pathways between the spinal cord and other parts of the brain go through the pons.

(4) *The medulla.* The medulla oblongata, a bulblike structure attaching the brain to the spinal cord, is a part of the brain stem. It contains vital centers controlling heart action, blood vessel diameter, and respirations. Mechanisms controlling nonvital functions such as sneezing, hiccoughing, and vomiting are also functions of the medulla. Nerve fibers cross from one side to the other in the medulla, a fact that explains why one side of the brain is said to control the opposite side of the body.

d. The Spinal Cord. The spinal cord, protected by meninges and vertebrae, is about 18 inches in length. The cord is continuous with the medulla of the brain and terminates at a level between the first and second lumbar vertebrae (fig. 2-9).

(1) The meninges inclosing the cord continue down below the termination of the cord and are anchored at the sacrum and coccyx. This anatomical feature makes it possible for a physician to withdraw samples of cerebrospinal fluid without danger of injuring the cord. When a patient is placed on his side and his back is arched by drawing his knees and chest together, the space between the fourth and fifth lumbar vertebrae is enlarged. A lumbar puncture needle can be inserted through the intervertebral space into the subarachnoid space to obtain spinal fluid for diagnostic tests. This feature also makes it possible to administer spinal anesthesia.

(2) The spinal cord has two major functions —conduction and connection. Many nerves enter and leave the spinal cord at different levels. These nerves all connect with nerve centers located within the spinal cord or with nerve centers in the brain. Nerve centers within the cord form the gray matter of the cord's inner core. Surrounding the gray matter are columns of nerve fibers, forming the white matter. The nerve fiber columns in the spinal cord are called tracts; these tracts connect the different levels of the nervous system. Tracts which transmit upward, the ascending tracts, are all sensory nerve fibers. Tracts which transmit impulses downward, the descending tracts, are all motor nerve fibers, controlling both voluntary and involuntary muscles. When the spinal cord is damaged, the extent of disability depends upon which nerve centers and which tracts are damaged.

(3) The soft spinal cord can be compressed by vertebrae fractures or by dislocation and displacement of vertebrae or vertebrae discs. If the

2-70. The Neuron and Nerves

a. The basic unit of the nervous system is the neuron, a cell specialized to respond to stimuli by transmitting impulses. Neurons differ in shape and function from all other body cells. Each neuron has three parts: a cell body and two kinds of processes extending from it (fig. 2-2 Ⓓ). Many branched processes, the dendrites, conduct impulses toward the cell body. A single process, the axon, conducts impulses away from the cell body. Impulses are the messages carried by the processes. All communication between nerve cells is carried out through these dendrites and axons at the region of contact (synapse) between processes of 2 adjacent neurons.

b. The neuron processes, whether dendrite or axon, are called fibers. These nerve fibers are wrapped in an insulating material, the myelin sheath. In addition to the myelin sheath, nerve fibers that extend outside the brain and spinal cord (peripheral nerves) have an outside wrapping called neurilemma. The neurilemma and the nerve cell body are essential for nerve regeneration following injury. In time, if the nerve cell body has not been destroyed, a peripheral nerve fiber can regenerate.

c. Nerve cells and nerve processes are bound together and supported by special connective tissue cells called neuroglia. Neuroglia literally means nerve glue. Several different kinds of neuroglia cells help form nerve tissue.

d. Nerves, which appear as whitish cords, are bundles of nerve fibers bound together by a connective tissue sheath.

2-71. The Central Nervous System

The central nervous system (CNS) consists of the brain and spinal cord. These are delicate structures that are protected by two coverings, bones and special membranes. The brain is encased by the bones of the skull that form the cranium; the spinal cord by the vertebrae. The membranes enclosing both brain and spinal cord are the meninges.

a. The Meninges. Three layers of protective membranes, the meninges, surround the brain and spinal cord. The outer layer of strong fibrous tissue is called the dura mater. The middle layer of delicate cobwebby tissue is the arachnoid. The innermost layer, adherent to the outer surface of the brain and spinal cord, is the pia mater. Between the dura mater and arachnoid is the subdural space; between the arachnoid and pia mater is the subarachnoid space.

b. Cerebrospinal Fluid. In addition to protective bones and membranes, nature provides a cushion of fluid around and within the subarachnoid space, in the spaces within the brain called the ventricles, and in the central canal of the spinal cord. Cerebrospinal fluid, which is similar to lymph, filters out from networks of capillaries in the ventricles. It is formed constantly, circulated constantly, and part of it is reabsorbed constantly into the venous blood of the brain. At any one time, an adult has about 135 ml. of this fluid circulating, although over 500 ml. is produced daily. If anything interferes with its circulation or its reabsorption, the fluid accumulates. An abnormal accumulation of cerebrospinal fluid is hydrocephalus (water on the brain).

c. The Brain. The brain (fig. 2-29), a mass of nervous tissue, is the highest level of the nervous system. It coordinates activities of the entire body; carries on the learning, thinking, and reasoning processes; and directs voluntary movements of the body. The brain may be divided into three parts: the cerebrum, cerebellum, and the brain-stem, the last consisting of the forebrain, midbrain, pons, and medulla. The midbrain serves as a connecting pathway between the right and left halves of the cerebrum and also between the cerebellum and the rest of the brain.

(1) *Cerebrum.* The cerebrum is described as resembling many small sausages bound together. It is the largest part of the brain, divided, not quite completely, into two hemispheres. Each hemisphere has five lobes. The outer surface, or cortex, of the brain is made up of gray matter, which is composed of nerve cells. The white matter within the brain is made up of nerve fibers, which lead to and from the cell bodies in the gray matter. Certain areas of the cerebrum are localized for certain functions, but it is believed that no one area functions independently. In the frontal lobe is the motor area, which controls voluntary movements, the speech center, and the writing center. In the parietal lobe is the general sensory area which perceives sensations of heat, cold, touch, pressure, pain, and position. In the temporal lobe are the centers for hearing and smelling. In the occipital lobe is the visual center.

(2) *Cerebellum.* The cerebellum lies below the posterior part of the cerebrum. It coordinates muscular activity at an unconscious level. It also

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tures. Each nephron has a capsule containing a cluster of capillaries called glomerulus. Leading from the capsule is a continuous looped tubule. The glomerulus filters the blood; the water, salts, waste products, and usable products pass from the capsule to the tubule; usable products and water are reabsorbed; and the final waste product, urine, drains from the last loop of the tubule. The glomerulus, the capsule, and the loops of tubule together form a nephron. Each part is essential for the coordinated filtration, reabsorption, and excretion process.

(2) Channels called collecting tubules form larger tubes and deliver the urine to the pelvis of the kidney.

2–64. Ureters

The pelvis of each kidney is drained by a ureter, a muscular tube extending from the hilus to the posterior portion of the urinary bladder. Ureters are smooth muscle structures, and urine is passed through each ureter by peristalsis. Drop by drop, urine passes into the bladder. Ureters are about 15 to 18 inches in length and about 1/5 inch in diameter.

2–65. Urinary Bladder

The urinary bladder, a muscular sac located in the lowest part of the abdominal cavity, stores urine. Normally it holds 300 to 500 ml. The bladder is emptied by contraction of muscles in its walls which force urine out through the urethra.

2–66. Urethra

The urethra is the tube that carries urine from the urinary bladder to the external opening, the urinary meatus. In the male, the urethra will vary in length. Including the portion within the body, it is approximately 6 to 7½ inches in length. It is divided into three areas: the prostatic which passes through the prostate gland; the membranous area, beneath the prostate; and the penile area (anterior), which passes through the penis (para 2–85). The female urethra, about 1½ inch long, extends from the bladder to the meatus, which is located above the vaginal opening.

2–67. Urine

Normal urine is an aromatic, transparent (clear) fluid. The color of normal urine varies from amber or pale yellow to a brownish hue. Freshly voided urine has a characteristic aromatic odor, while stale urine has strong ammonia odor. The average quantity of urine excreted by a normal adult in 24 hours ranges from 1,500 to 2,000 ml., depending upon the fluid intake, amount of perspiration, and other factors. Urine contains protein wastes (urea), salts in solution, hormones, and pigments. (Normal urine should not contain blood, albumin, sugar, or pus cells.)

2–68. Urination

Urination is the discharge or voiding of urine. It is done by a contraction of the bladder and relaxation of the sphincters. In the adult, the act of voiding, although dependent on involuntary reflexes, is partly under voluntary control. Voluntary contraction of abdominal muscles usually accompanies and aids urination.

Section X. THE NERVOUS SYSTEM

2–69. General

a. The nervous system has two major functions, communication and control. It enables the individual to be aware of and to react to his environment. It coordinates the body's responses to stimuli and keeps body systems working together. (Stimuli are changes in environment that require adjustment of body activities.)

b. The nervous system consists of nerve centers and of nerves that branch off from them and lead to tissues and organs. Most nerve centers are in the brain and spinal cord. Nerves carry impulses from tissues and organs to nerve centers, and from these centers to tissues and organs. The neurons that carry impulses from the skin and other sense organs to the central nervous system are sensory neurons. They make the body aware of its environment. The neurons that carry impulses from the central nervous system to muscles and glands are motor neurons. They cause the body to react to its environment.

c. For study, parts of the nervous system may be considered separately as: the central nervous system, which consists of the brain and spinal cord; the peripheral nervous system, where the nerves are located outside the brain and spinal cord; and the autonomic nervous system, which influences the activities of involuntary muscle and gland tissue.

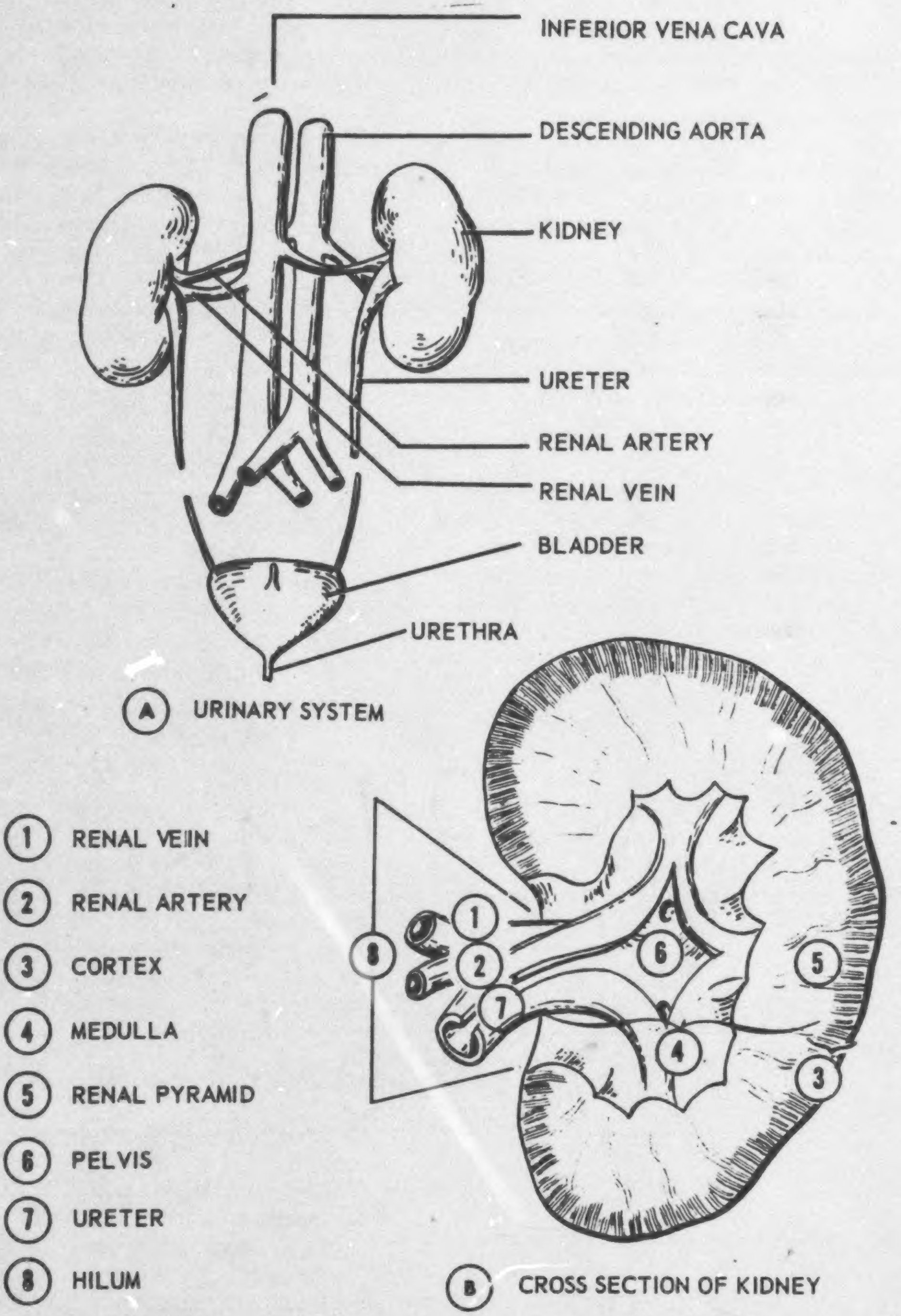
INFERIOR VENA CAVA
DESCENDING AORTA
KIDNEY
URETER
RENAL ARTERY
RENAL VEIN
BLADDER
URETHRA
A URINARY SYSTEM
1 RENAL VEIN
2 RENAL ARTERY
3 CORTEX
4 MEDULLA
5 RENAL PYRAMID
6 PELVIS
7 URETER
8 HILUM
B CROSS SECTION OF KIDNEY

Figure 2–28. Urinary system and cross section of kidney.

b. The kidney is composed of an outer shell or cortex, and an inner layer, the medulla. The cortex is made of firm, reddish-brown tissue containing millions of microscopic filtration plants, called nephrons. Each nephron is a urine-forming unit. The nephron units receive and filter all the body's blood about once every 12 minutes. During this period, they draw off and filter the liquid portion of blood, remove liquid wastes (urine), and return the usable portion to the circulation to maintain the body's fluid balance.

(1) Nephrons are very complicated struc-

67

(descending colon). The last portion makes an S curve (sigmoid) toward the center and posterior of the abdomen and ends in the rectum.

c. The main function of the large intestine is the recovery of water from the mass of undigested food it receives from the small intestine. As this mass passes through the colon, water is absorbed and returned to the tissues. Waste materials, or feces, become more solid as they are pushed along by peristaltic movements. Constipation is caused by delay in movement of intestinal contents and removal of too much water from them. Diarrhea results when movement of the intestinal contents is so rapid that not enough water is removed.

2–58. The Rectum and Anus

The rectum is about 5 inches long and follows the curve of the sacrum and coccyx until it bends back into the short anal canal. The anus is the external opening at the lower end of the digestive system. It is kept closed by a strong sphincter muscle. The rectum receives feces and periodically expels this material through the anus. This elimination of refuse is called defecation.

2–59. Time Required for Digestion

Within a few minutes after a meal reaches the stomach, it begins to pass through the lower valve of the stomach. After the first hour the stomach is half empty, and at the end of the sixth hour none of the meal is present in the stomach. The meal goes through the small intestine, and the first part of it reaches the cecum in 20 minutes to 2 hours. At the end of the sixth hour most of it should have passed into the colon; in 12 hours all should be in the colon. Twenty-four hours from the time when food is eaten, the meal should reach the rectum. However, part of a meal may be defecated at one time and the rest at another.

2–60. Absorption of Digested Food
(fig. 2–27)

There is very little absorption in the stomach. Most absorption takes place in the small intestine. The final products of digestion pass through the mucous membrane lining of the gastrointestinal tract and are carried to the liver and from there to the rest of the body. There is marked absorption of water in the large intestine. The residue is concentrated and expelled as feces.

2–61. Defecation

The passage of feces is called defecation. It is begun voluntarily by contraction of the abdominal muscles. At the same time, the sphincter muscles of the anus relax and there is a peristaltic contraction wave of the colon and rectum. Feces are expelled as a result of all these actions. Feces consist of undigested food residue, secretions from the digestive glands, bile, mucus, and millions of bacteria. Mucus is derived from the many mucous glands which pour secretions into the intestine. Bacteria are especially numerous in the large intestine. They act upon food material, causing putrefaction of proteins and fermentation of carbohydrates. Although the bacteria normally in the large intestine serve a useful purpose internally, they are contaminants outside the intestine.

Section IX. THE URINARY SYSTEM

2–62. Description

The urinary system (fig. 2–28), which filters and excretes waste materials from the blood, consists of two kidneys, two ureters, one urinary bladder, and one urethra. The urinary system helps the body maintain its delicate balance of water and various chemicals in the proportions needed for health and survival. During the process of urine formation, waste products are removed from circulating blood for elimination, and useful products are returned to the blood.

2–63. Kidney

a. The kidneys are bean-shaped organs (fig. 2–28), about 4½ inches long, 2 inches wide, and 1 inch thick. They lie on each side of the spinal column, against the posterior wall of the abdominal cavity, near the level of the last thoracic vertebra and the first lumbar vertebra. The right kidney is usually slightly lower than the left. Near the center of the medial side of each kidney is the central notch or hilum, where blood vessels and nerves enter and leave and from which the ureter leaves.

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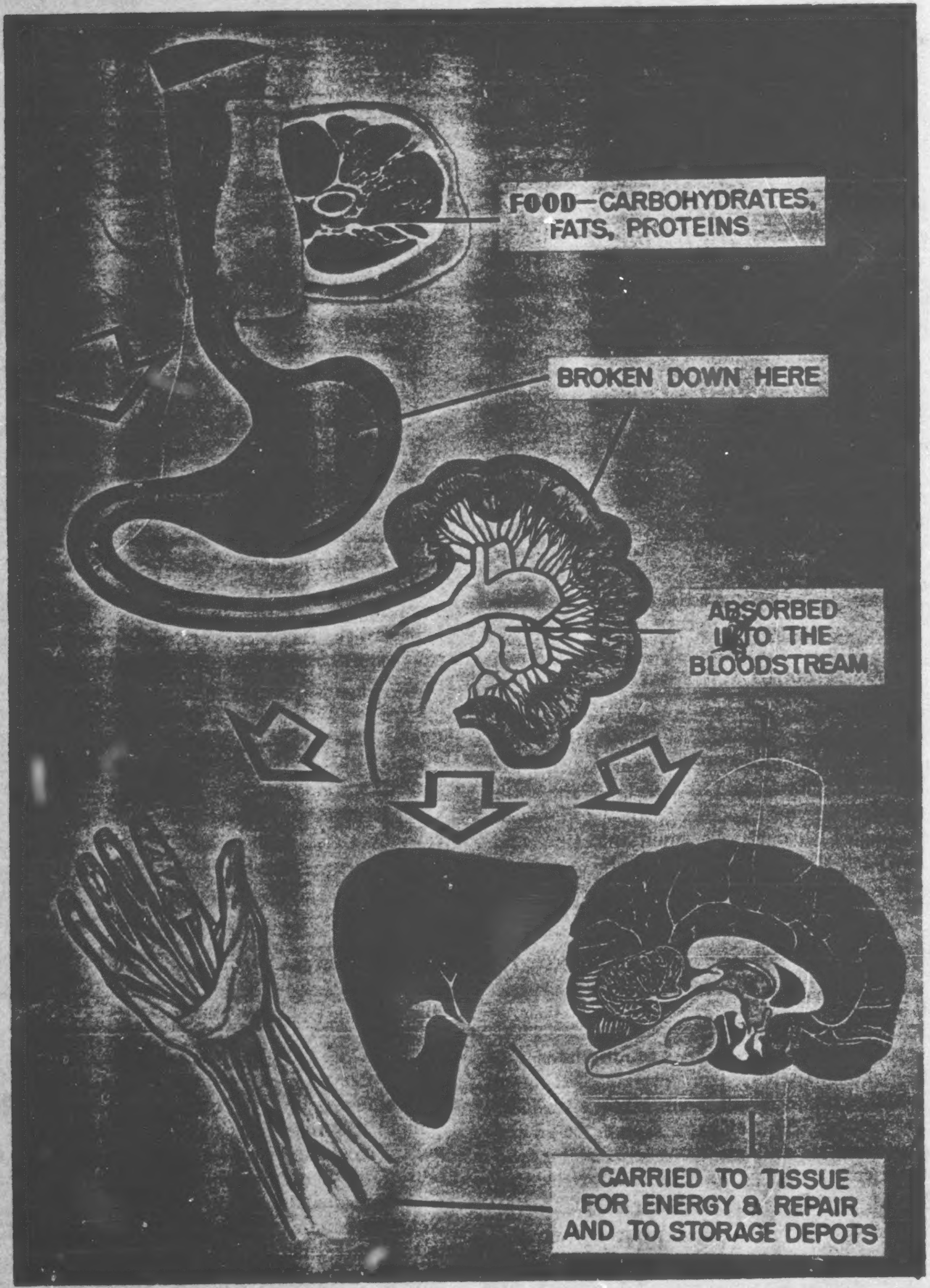
FOOD—CARBOHYDRATES, FATS, PROTEINS
BROKEN DOWN HERE
ABSORBED INTO THE BLOODSTREAM
CARRIED TO TISSUE FOR ENERGY & REPAIR AND TO STORAGE DEPOTS

Figure 2-27. Assimilation of food.

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a. It acts as a storehouse for food, receiving fairly large amounts, churning it, and breaking it down further for mixing with digestive juices. Semiliquid food is released in small amounts by the pyloric valve into the duodenum, the first part of the small intestine.

b. The glands in the stomach lining produce gastric juices (which contain enzymes) and hydrochloric acid. The enzymes in the gastric juice start the digestion of protein foods, milk, and fats. Hydrochloric acid aids enzyme action. The mucous membrane lining the stomach protects the stomach itself from being digested by the strong acid and powerful enzymes.

2–56. Small Intestine

The small intestine is a tube about 22 feet long. The intestine is attached to the margin of a thin band of tissue called the mesentery, which is a portion of the peritoneum, the serous membrane lining the abdominal cavity. The mesentery supports the intestine, and the vessels which carry blood to and from the intestine lie within this membrane. The other edge of the mesentery is drawn together like a fan; the gathered margin is attached to the posterior wall of the abdomen. This arrangement permits folding and coiling of the intestine so that this long organ can be packed into a small space. The intestine is divided into three continuous parts: duodenum, jejunum, and ileum. It receives digestive juices from three accessory organs of digestion: the pancreas, liver, and gall bladder (fig. 2–26).

a. Pancreas. The pancreas is a long, tapering organ lying behind the stomach. The head of the gland lies in the curve of the small intestine near the pyloric valve. The body of the pancreas extends to the left toward the spleen. The pancreas secretes a juice which acts on all types of food. Two enzymes in pancreatic juice act on proteins. Other enzymes change starches into sugars. Another enzyme changes fats into their simplest forms. The pancreas has another important function, the production of insulin (para 2–83).

b. Liver. The liver is the largest organ in the body. It is located in the upper part of the abdomen with its larger (right) lobe to the right of the midline. It is just under the diaphragm and above the lower end of the stomach. The liver has several important functions. One is the secretion of bile, which is stored in the gall bladder and discharged into the small intestine when digestion is in process. The bile contains no enzymes but it breaks up the fat particles so that enzymes can act faster. The liver performs other important functions. It is a storehouse for the sugar of the body (glycogen) and for iron and vitamin B. It plays a part in the destruction of bacteria and wornout red blood cells. Many chemicals such as poisons or medicines are detoxified by the liver; others are excreted by the liver through bile ducts. The liver manufactures part of the proteins of blood plasma. The blood flow in the liver is of special importance. All the blood returning from the spleen, stomach, intestines, and pancreas is detoured through the liver by the portal vein in the portal circulation (fig. 2–17). Blood drains from the liver by hepatic veins which join the inferior vena cava.

c. Gall Bladder. The gall bladder is a dark green sac, shaped like a blackjack and lodged in a hollow on the underside of the liver. Its ducts join with the duct of the liver to conduct bile to the upper end of the small intestine. The main function of the gall bladder is the storage and concentration of the bile when it is not needed for digestion.

d. Ileum. Most of the absorption of food takes place in the ileum. The walls of the ileum are covered with extremely small, finger-like structures called villi which provide a large surface for absorption. After food has been digested, it is absorbed into the capillaries of the villi. Then it is carried to all parts of the body by the blood and lymph.

2–57. Large Intestine (Colon)

a. The large intestine is about 5 feet long. The cecum (fig. 2–26), located on the lower right side of the abdomen, is the first portion of the large intestine into which food is emptied from the small intestine. The appendix extends from the lower portion of the cecum and is a blind sac. Although the appendix usually is found lying just below the cecum, by virtue of its free end it can extend in several different directions, depending upon its mobility.

b. The colon extends along the right side of the abdomen from the cecum up to the region of the liver (ascending colon). There the colon bends (hepatic flexure) and is continued across the upper portion of the abdomen (transverse colon) to the spleen. The colon bends again (splenic flexure) and goes down the left side of the abdomen *b*. The accessory organs that aid the process of digestion are: the salivary glands, pancreas, liver, gall bladder, and intestinal glands.

2-52. The Mouth

The mouth, or oral cavity, is the beginning of the digestive tract. Here food taken into the body is broken into small particles and mixed with saliva so that it can be swallowed.

a. Teeth.

(1) A person develops two sets of teeth during his life, a deciduous (or temporary) set and a permanent set. There are 20 deciduous teeth and these erupt during the first 3 years of life. They are replaced during the period between the 6th and 14th years by permanent teeth. There are 32 permanent teeth in the normal mouth; 4 incisors, 2 cuspids, 4 bicuspids, and 6 molars in each jaw. Each tooth is divided into two main parts: the crown, that part which is visible above the gums; and the root, that part which is not visible and which is embedded in the bony structure of the jaw. The crown of the tooth is protected by enamel. Tooth decay is from the outside in; once the protective enamel is broken, microorganisms attack the less resistant parts of the tooth.

(2) The primary function of the teeth is to chew or masticate food. Secondarily, the teeth help to modify sound as produced by the larynx and as used in forming words.

b. Salivary Glands. These glands are the first accessory organs of digestion. There are three pairs of salivary glands. They secrete saliva into the mouth through small ducts. One pair, the parotid glands, is located at the side of the face below and in front of the ears. The second pair, the submandibular glands, lies on either side of the mandible. The third pair, the sublingual glands, lies just below the mucous membrane in the floor of the mouth. The flow of saliva is begun in several ways. Placing food in the mouth affects the nerve endings there. These nerve endings stimulate cells of the glands to excrete a small amount of thick fluid. The sight, thought, or smell of food also activates the brain and induces a large flow of saliva. About 1,500 ml. of saliva are secreted daily. The saliva moistens the food, which makes chewing easier. It lubricates the food mass to aid in the act of swallowing. Saliva contains two enzymes, chemical ferments which change foods into simpler elements. The enzymes act upon starches and break them down into sugars.

c. Tongue. The tongue is a muscular organ attached at the back of the mouth and projecting upward into the oral cavity. It is concerned in taste, speech, mastication, salivation, and swallowing. After food has been masticated, the tongue propels it from the mouth into the pharynx. This is the first stage of swallowing. Mucus secreted by glands in the tongue lubricates the food and makes swallowing easier. Taste buds situated in the tongue make it the principal organ of the sense of taste. Stimulation of the taste buds causes secretion of gastric juices needed for the breaking down of food in the stomach.

2-53. Pharynx

The pharynx is a muscular canal which leads from the nose and mouth to the esophagus. The passage of food from the pharynx into the esophagus is the second stage of swallowing. When food is being swallowed, the larynx is closed off from the pharynx to keep food from getting into the respiratory tract.

2-54. The Esophagus

The esophagus is a muscular tube about 10 inches long, lined with a mucous membrane. It leads from the pharynx through the chest to the upper end of the stomach (fig. 2-26). Its function is to complete the act of swallowing. The involuntary movement of material down the esophagus is carried out by the process known as peristalsis, which is the wavelike action produced by contraction of the muscular wall. This is the method by which food is moved throughout the alimentary canal.

2-55. The Stomach

The stomach is an elongated pouchlike structure (fig. 2-26) lying just below the diaphragm, with most of it to the left of the midline. It has three divisions: the fundus, the enlarged portion to the left and above the entrance of the esophagus; the body, the central portion; and the pylorus, the lower portion. Circular sphincter muscles which act as valves guard the opening of the stomach. (The cardiac sphincter is at the esophageal opening, and the pyloric sphincter is at the junction of the stomach and the duodenum, the first portion of the small intestine.) The cardiac sphincter prevents stomach contents from re-entering the esophagus except when vomiting occurs. In the digestive process (fig. 2-27), two of the important functions of the stomach are—

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2-51. Structure of Digestive System (fig. 2-26)

a. The alimentary canal is about 28 feet long, extending from the lips to the anus, and is divided as follows:

Mouth cavity:
    Teeth
    Tongue
Pharynx
Esophagus
Stomach
Small intestine
Large intestine (colon)
Rectum
Anus

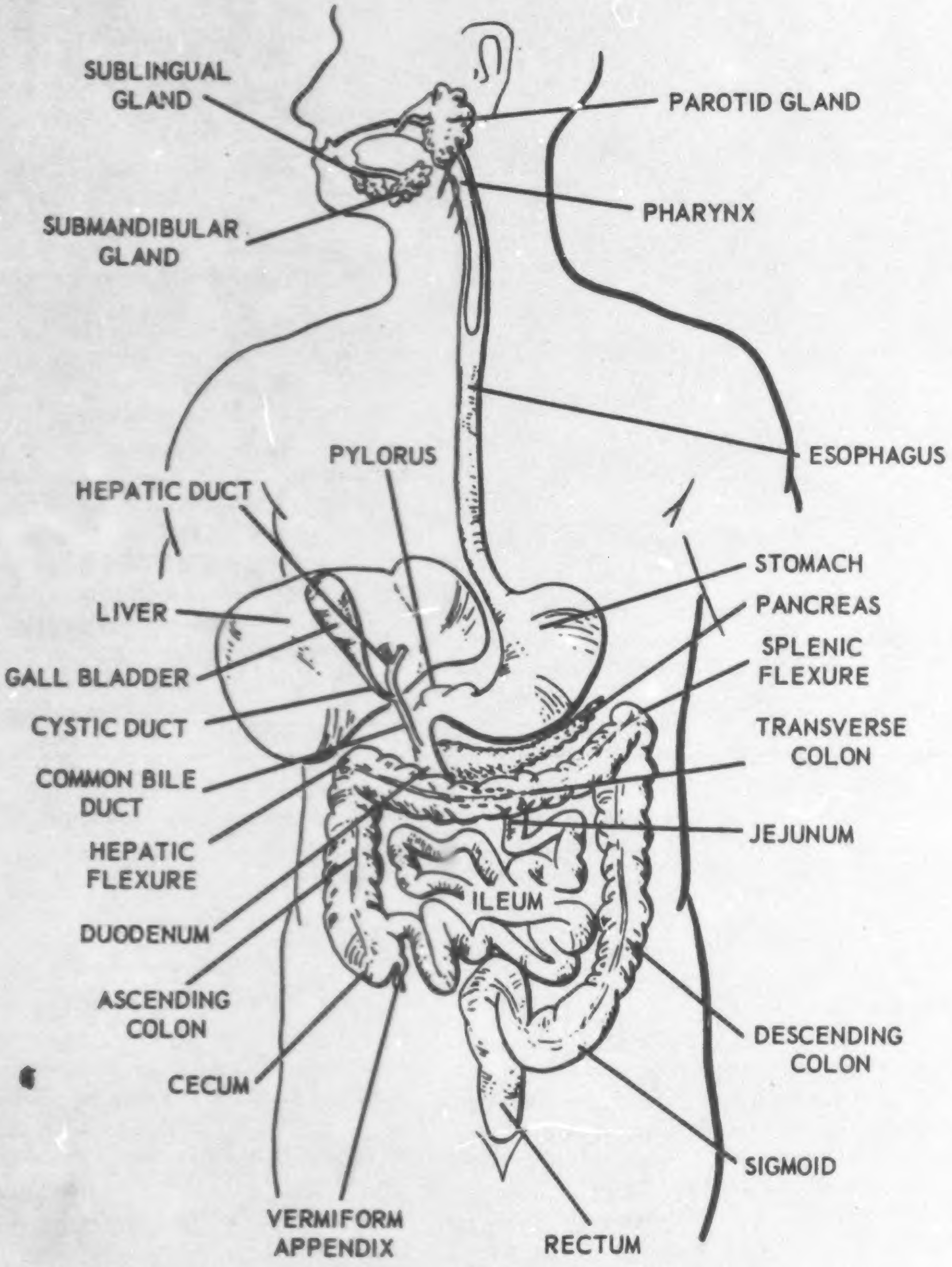
SUBLINGUAL GLAND
PAROTID GLAND
SUBMANDIBULAR GLAND
PHARYNX
ESOPHAGUS
PYLORUS
HEPATIC DUCT
STOMACH
LIVER
PANCREAS
GALL BLADDER
SPLENIC FLEXURE
CYSTIC DUCT
TRANSVERSE COLON
COMMON BILE DUCT
JEJUNUM
HEPATIC FLEXURE
ILEUM
DUODENUM
ASCENDING COLON
DESCENDING COLON
CECUM
SIGMOID
VERMIFORM APPENDIX
RECTUM

Figure 2-26. Digestive system.

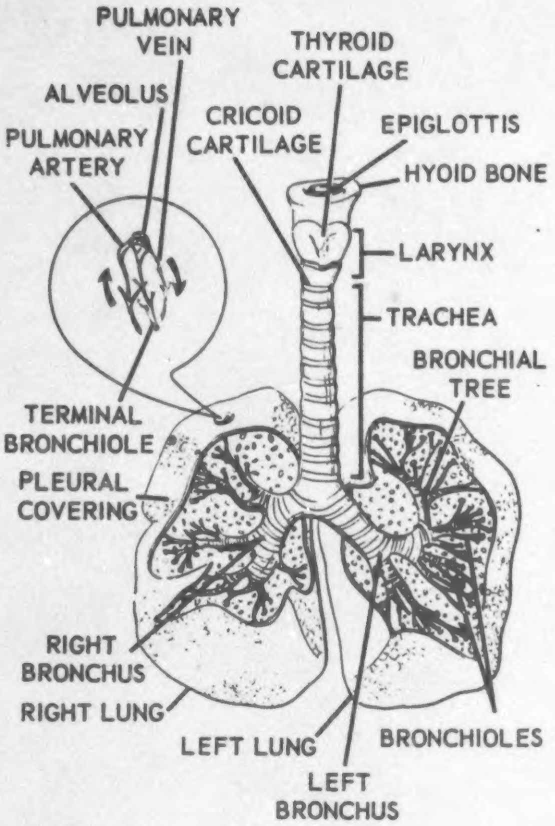
PULMONARY VEIN
THYROID CARTILAGE
ALVEOLUS
CRICOID CARTILAGE
EPIGLOTTIS
PULMONARY ARTERY
HYOID BONE
LARYNX
TRACHEA
BRONCHIAL TREE
TERMINAL BRONCHIOLE
PLEURAL COVERING
RIGHT BRONCHUS
RIGHT LUNG
LEFT LUNG
BRONCHIOLES
LEFT BRONCHUS

Figure 2–24. Lungs and air passages.

ing the floor of the thoracic cavity, contracts, flattening its domed upper surface and increasing the size of the cavity. At about the same time, muscles attached to the ribs (intercostals) contract to elevate and spread the ribs. This further increases the size of the cavity. Air rushes into the lungs and they expand, filling the enlarged cavity.

b. Expiration. At rest, during quiet breathing, expiration is a passive movement. The diaphragm, as it relaxes, is forced upward by intra-abdominal pressure. Muscles attached to the ribs relax, permitting the chest to flatten. These actions reduce the size of the thoracic cavity, allowing the elastic recoil of the stretched lungs to drive out the air. More air can be expelled from the lungs by forced expiration. This is done by contraction of the abdominal muscles, forcing the diaphragm upward, and of the muscles attached to the ribs, flattening the chest to compress the lungs and drive out the air. When breathing becomes forced, as with exercise, expiration also becomes active.

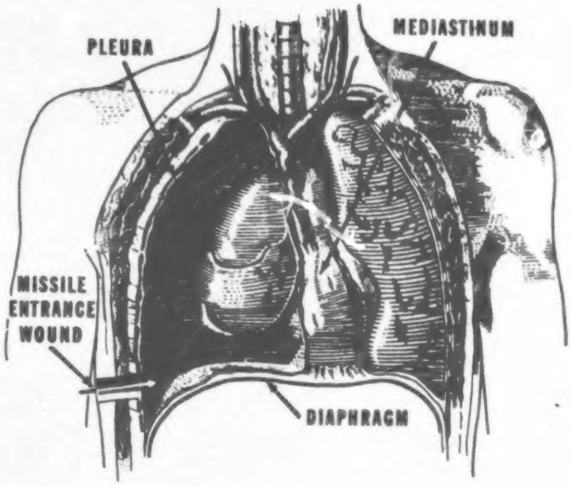
PLEURA
MEDIASTINUM
MISSILE ENTRANCE WOUND
DIAPHRAGM

Figure 2–25. Collapse of lungs by a sucking chest wound.

c. Volume. About 500 milliliters (1 pint) of air are inhaled during normal respiration. By deep inspiration it is possible to inhale an additional 1,500 milliliters.

d. Sounds. Sounds caused by air moving in the lungs change with some diseases. These changes, heard with a stethoscope, assist in diagnosis of diseases of the lungs such as pneumonia or tuberculosis.

Section VIII. THE DIGESTIVE SYSTEM

2–50. Description

a. The digestive system is made up of the alimentary tract (food passage) and the accessory organs of digestion. Its main functions are to ingest and carry food so that digestion and absorption can occur, and to eliminate unused waste material. The products of the accessory organs help to prepare food for its absorption and use (metabolism) by the tissues of the body.

b. Digestion consists of two processes, one mechanical and the other chemical. The mechanical part of digestion includes chewing, swallowing, peristalsis, and defecation. The chemical part of digestion consists of breaking foodstuffs into simple components which can be absorbed and used by the body. In this process, foodstuffs are broken down by enzymes, or digestive juices, formed by digestive glands. Carbohydrates are broken into simple sugar (glucose). Fats are changed into fatty acids. Proteins are converted to amino acids.

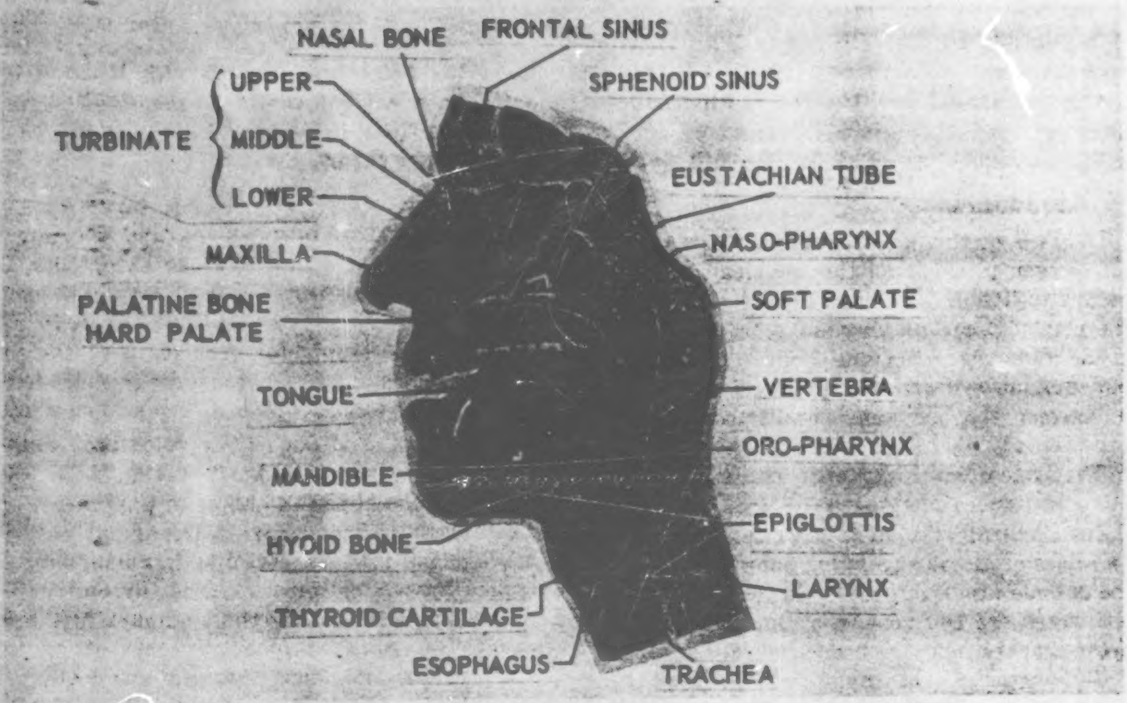

Figure 2–23. Upper respiratory tract.

sections of the thoracic cavity. The upper, pointed margin of each lung, the apex, extends above the clavicle. The lower border, the base, fits upon the dome-shaped surface of the diaphragm. Between the two lungs is the mediastinum (fig. 2–25), the central thoracic cavity containing the heart, great blood vessels, esophagus, and lower trachea. The right lung has three lobes; the left lung has two. Within each lobe are separate branches of the main bronchus, and the lobes themselves are divided into segments. The last subdivisions of the air passages to the lungs are alveoli, which are surrounded by networks of capillaries. The alveoli are air chambers.

(2) Each lung is inclosed by a membranous sac formed of two layers of serous membranes called the pleurae (or singly, pleura). One layer covers the lungs (visceral pleura); the other lines the chest cavity (parietal pleura). If air enters the pleural sac, it expands to form a large cavity and the lung collapses (fig. 2–25). This condition of air in the chest outside the lungs is called pneumothorax. If air can move through a hole into the chest, it is called open pneumothorax, a life-endangering condition. An open pneumothorax can result from a bullet wound, stab wound, or other injury that makes a hole in the chest.

2–48. Physiological Process of Respiration

The walls of the alveoli are very thin and it is here that oxygen passes into the bloodstream and carbon dioxide is taken from it. This exchange of oxygen and carbon dioxide in the lungs is called external respiration. The oxygen which enters the blood is carried by the red blood cells in chemical combination with hemoglobin. The blood, oxygenated in the lungs, returns to the heart, then is pumped through the arteries to the capillaries. Here oxygen from the blood passes to the tissue cells and carbon dioxide from the cells passes into the blood to be carried back by the veins to the heart. The exchange of gases between the capillary blood and the tissue cells is called internal respiration.

2–49. Mechanical Process of Respiration

The act of breathing, the cycle of inspiration and expiration, is repeated about 16 to 20 times per minute in an adult at rest. Breathing is regulated primarily by a respiratory center in the brain. The respiratory center is sensitive to changes in blood composition, temperature, and pressure, and adjusts breathing according to the body's needs.

a. Inspiration. This is an active movement. The diaphragm, the large, dome-shaped muscle form-

b. Rh Factor. In addition to blood grouping and cross-matching for compatibility, the Rh factor must be considered. The Rh factor is carried in red cells, and about 85 percent of all individuals have this factor and are, therefore, Rh positive. Individuals who do not have the Rh factor are Rh negative. As a general rule, Rh negative blood can be given to anyone, provided it is compatible in the ABO typing system, but Rh positive blood should not be given to an Rh negative individual.

Section VII. THE RESPIRATORY SYSTEM

2-46. Introduction

a. The cells of the body require a constant supply of oxygen to carry on the chemical processes necessary to life. As a result of these processes, a waste product, carbon dioxide, is formed that must be removed from the body. Oxygen and carbon dioxide are continually being exchanged, both between the body and the atmosphere and within the body, by the process known as respiration. The system which performs this exchange of gases is the respiratory system.

b. The respiratory system consists of the lungs and a series of air passages that connect the lungs to the outside atmosphere. The organs serving as air passages are the nose, the pharynx, the larynx, the trachea, and the bronchi. They carry air into the depths of the lungs and end there in thin-walled sacs, the alveoli, where carbon dioxide is exchanged for oxygen.

2-47. Structure and Function of the Respiratory System

a. Nose. The nose consists of two portions, one external and the other internal (nasal cavity). The external nose is a triangular framework of bone and cartilage covered by skin. On its under surface are the nostrils, the two external openings of the nasal cavity. The nasal cavity is divided in two by the nasal septum, and is separated from the mouth by the palate. Inhaled air is warmed, moistened, and filtered by the nasal cavity. The filtering is done by cilia of the mucous membrane lining the nasal passages. Cilia are numerous, long, microscopic processes which beat or wave together and cause movement of materials across the surface and out of the body. Ciliary movement is important in draining the sinuses.

b. Air Sinuses. Air spaces in several bones of the face and head open into the nasal cavity. They serve as resonance chambers in the production of voice and decrease the weight of the skull. These air sinuses (fig. 2-23) take the name of the bone in which they are found. They are lined with mucous membrane continuous with that lining the nasal cavity.

c. Pharynx. The pharynx, or throat, connects the nose and mouth with the lower air passages and esophagus. It is divided into three parts: the nasopharynx, the oropharynx, and the laryngopharynx. It is continued as the esophagus. Both air and food pass through the pharynx. It carries air from the nose to the larynx, food from the mouth to the esophagus. The walls of the pharynx contain masses of lymphoid tissues called the adenoids and tonsils.

d. Larynx. The larynx, or voice box, connects the pharynx with the trachea (fig. 2-23). It is located in the upper and anterior part of the neck. The larynx is shaped like a triangular box. It is made of 9 cartilages joined by ligaments and controlled by skeletal muscles. The thyroid cartilage is the largest. It forms the landmark in the neck called the "Adam's apple." Another of the cartilages is the epiglottis. During swallowing, the epiglottis closes the larynx, the soft palate closes the nasal cavity, and the lips close the mouth. Thus food is forced into the only remaining opening, the esophagus. Except during swallowing or when the throat is voluntarily closed, the air passages are wide open and air is free to pass from the mouth and nose into the lungs. Two membranous bands in the wall of the larynx are called vocal cords. Vibration of the vocal cords produce sounds. The cricoid cartilage, located just below the prominent thyroid cartilage, is joined to the thyroid cartilage by a membrane. The emergency procedure of cricothyroidotomy to produce an airway is performed by puncturing this connecting membrane.

e. Trachea. The trachea, or windpipe, is a tube held open by cartilaginous rings. It carries air from the larynx to the bronchi (fig. 2-24). The trachea is lined with cilia and mucous glands whose secretions provide a sticky film to keep dust and dirt out of the lungs.

f. Bronchi. The trachea divides to form the two bronchi. One bronchus enters each lung and there divides into many small air passages, called bronchioles or bronchial tubes which lead air into the final air spaces within the lungs.

g. The Lungs.

(1) The lungs (fig. 2-24) are the soft, air-filled, essential organs of respiration. They are elastic structures, almost filling the left and right

blood when the walls of a blood vessel are broken or cut open. When undisturbed, blood circulates in its vascular system without showing a tendency to clot. However, when blood leaves its natural environment, certain physical and chemical factors are changed and it begins to clot almost at once. At first the clot is soft and jellylike, but it soon becomes firm and acts as a plug, preventing the further escape of blood.

b. It takes 3 to 5 minutes for blood to clot, but sometimes it is necessary to hold back the clotting process. This is done with drugs called anticoagulants.

2–44. Hemorrhage

Hemorrhage is bleeding, particularly excessive bleeding, from blood vessels due to a break in their walls. It may be caused by a wound or by disease. Whatever its cause, it can be a serious threat to life and calls for prompt control. Hemorrhage can occur either externally or internally. External hemorrhage is bleeding that can be seen, such as bleeding from a wound. In external hemorrhage, blood escapes to the outside and spills onto the surface of some part of the body. Internal hemorrhage happens inside the body, spilling blood into tissues, a body cavity, or an organ. It can occur without any blood being seen outside the body. Bleeding in some internal areas is evident, however, when blood accumulates in tissues (forming a hematoma), or is vomited, coughed up, or excreted in urine or feces.

a. Effects of Hemorrhage. The effects of hemorrhage depend on the amount of blood lost, the rate of loss, and the area into which internal bleeding occurs. Generally, blood pressure drops and breathing and pulse rates become rapid. When blood is lost rapidly, as in bleeding from an artery, blood pressure may drop suddenly. If only small vessels are injured and bleeding is slow, a large amount of blood may be lost without an immediate drop in blood pressure.

b. Natural Measures to Control Hemorrhage. When a blood vessel is opened, the body reacts with measures to check bleeding. Two natural body responses to bleeding are clotting of blood and retraction and constriction of blood vessels. The muscle in an injured artery contracts, and if the artery is severed, the contraction pulls the damaged vessel back into the tissues, thus tending to close the leak. As a rule, these natural responses must be helped by artificial means for controlling hemorrhage and for restoring the blood. Artificial means for controlling external hemorrhage include two important first aid measures—elevation of bleeding extremities and applying pressure dressings.

2–45. Blood Types

All human blood may be divided into four main types or groups—O, A, B, AB. This system of typing is used to prevent incompatible blood transfusion, which causes serious reactions and sometimes death. Certain types of blood are incompatible or not suited to each other if combined. Two bloods are said to be incompatible when the plasma or serum of one blood causes clumping of the cells of the other. Two bloods are said to be compatible and safe for transfusion if the cells of each can be suspended in the plasma or serum of the other without clumping. Blood typing and cross-matching are done by highly trained laboratory technicians. Table 2–2 shows blood compatibilities and incompatibilities.

a. Importance of Blood Types. From table 2–2, it is evident that if the donor's blood is type "O" it is compatible with all types of recipient blood; or, in other words, type "O" is the universal donor. If the recipient's blood is type "AB", it is compatible with all types of donor blood, or, in other words, type "AB" is the universal recipient. When a blood transfusion is given, the blood type of both donor and recipient should be identical, and their compatibility must be proved by a cross-matching test. However, when blood of the same type is not available and death may result if transfusion is delayed, a type "O" donor (universal donor) may be used if the cross-matching is satisfactory.

Table 2-2. Blood Types

Donor	Recipient			
	O	A	B	AB
O	Compatible	Compatible	Compatible	Compatible
A	Incompatible	Compatible	Incompatible	Compatible
B	Incompatible	Incompatible	Compatible	Compatible
AB	Incompatible	Incompatible	Incompatible	Compatible

(2) *Blood cells.* The cellular elements in the blood are red cells (erythrocytes, or rbc), white cells (leucocytes, or wbc) and blood platelets (thrombocytes).

2–40. Red Blood Cells (Erythrocytes)

There are about 5,000,000 red blood cells in 1 cubic millimeter (cmm.) of blood. (One cmm. is a very small amount, about 1/25 of a drop). When viewed under a microscope, an individual red blood cell is disc-shaped. An rbc is the only mature body cell that has no nucleus; this fact is important in the diagnosis of some blood disease, because immature red blood cells which do have a nucleus under normal circumstances do not appear in the blood. When nucleated rbc are found, there is a special significance since this may indicate a type of anemia. Red cells are formed in the adult by the red bone marrow in special protected bone areas. Millions of red cells are thought to be destroyed daily, either in the liver, the spleen, the lymph nodes, or in the vascular system itself. In a healthy person, the rate of destruction is equaled by the rate of production, so that a red count of about 5,000,000 per cubic millimeter remains constant. Red blood cells have an average life span of about 90 to 120 days before becoming worn out in service.

a. Hemoglobin. A pigment, hemoglobin, gives red cells their color. Hemoglobin (Hgb) has the power to combine with oxygen, carrying it from the lungs to the tissue cells. Hgb assists in transporting carbon dioxide from the cells to the lungs. This transportation of gases (oxygen and carbon dioxide) is the principal function of red cells. The oxygen content gives arterial blood its bright red color. In order to carry oxygen, hemoglobin needs the mineral, iron, which is ordinarily available in a nutritionally adequate diet.

b. Anemia. The condition known as anemia is due to a reduction in number of red cells or a reduction in the hemoglobin content of red cells.

2–41. White Cells (Leucocytes)

White cells vary in size and shape, and are larger and much fewer in number than red cells. The average number in an adult is 5,000 to 10,000 in 1 cmm. of blood. Their function is primarily one of protection. They can ingest and destroy foreign particles, such as bacteria, in the blood and tissues. This function is called phagocytosis, and the white cells performing it are phagocytes. White cells are capable of ameboid movement and thus can pass through the walls of capillaries into surrounding tissues. This ability to enter tissue makes them very useful in fighting infection—an area of infection is characterized by a great increase of white cells which gather about the site to destroy bacteria. An example of this is seen in an ordinary boil (furuncle). The pus contained in the boil is made up largely of white cells, plus bacteria and dissolved tissue. Many of the white cells are killed in their struggle with invading bacteria.

a. Kinds of White Cells. There are several kinds of white cells. The most numerous, neutrophils, make up about 65 percent of all white cells and are called polymorphonuclear granulocytes. Certain very potent drugs interfere with the formation of these valuable cells, and the condition agranulocytosis (absence of granulocytes) develops. When drugs with this known toxic effect must be used in treatment of a disease, the doctor orders frequent white cell blood counts as an important part of the treatment. Neutrophils are produced by the red bone marrow.

b. Leucocytosis. In various diseases, the number of white cells in the blood stream may increase considerably, especially in acute infections. This increase is leucocytosis, and it is an important body defense response. A common condition where there is a leucocytosis is acute appendicitis. (A subnormal white count is known as leucopenia.)

c. Lymphocytes. Lymphocytes are white cells produced in lymphoid tissue. One type of lymphocyte is a monocyte, the largest white cells.

2–42. Blood Platelets (Thrombocytes)

Blood platelets, which are smaller than red blood cells, are thought to be fragments of cells formed in the bone marrow. Platelets number about 300,000 per cmm. of blood. Their main function is to aid in the coagulation of blood at the site of a wound. Platelets when injured release a substance to hasten formation of a blood clot.

2–43. Coagulation of Blood

a. Blood coagulation, or clotting, is the body's major method of preventing excessive loss of

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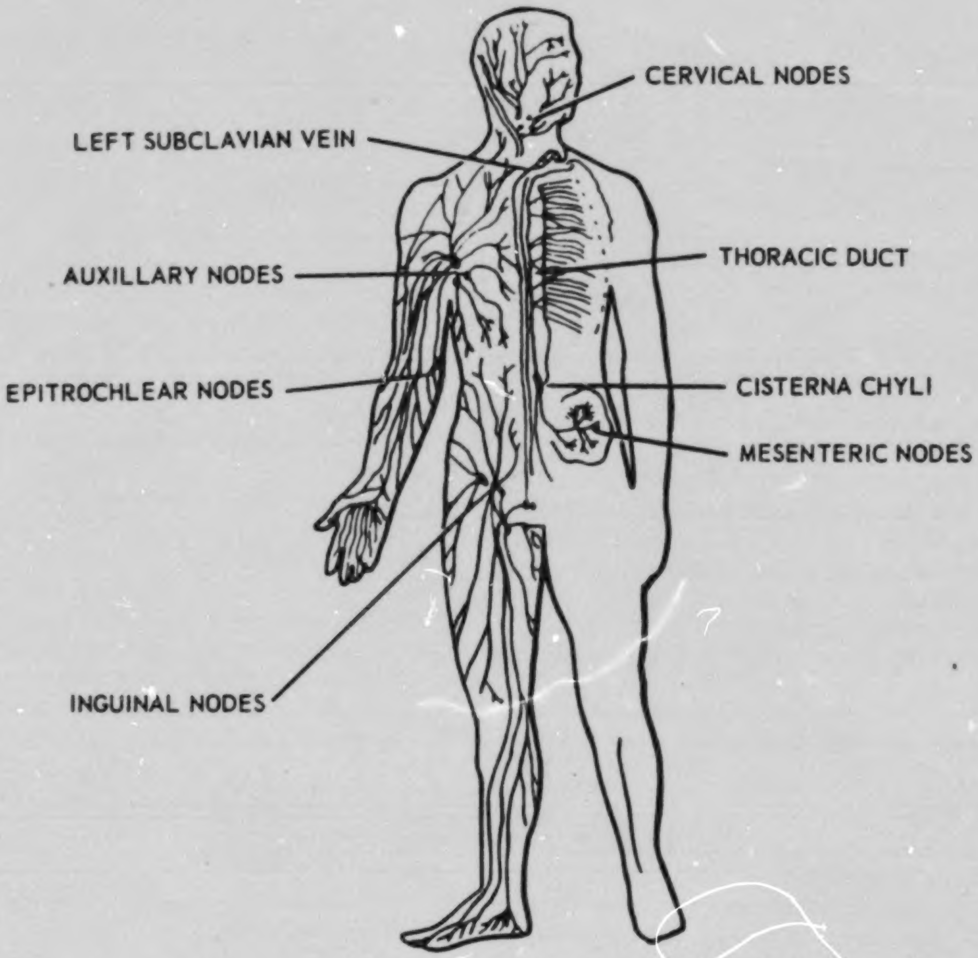

Figure 2-22. Lymphatic system.

from bright red (oxygenated blood) when it flows from arteries, to dark red (deoxygenated blood) when it flows from veins. The average man has about 6000 ml. of blood.

a. Functions of Blood. The six major functions of blood are all carried out when blood circulates normally through the blood vessels. These functions are—

(1) To carry oxygen from the lungs to tissue cells and carbon dioxide from the cells to the lungs.

(2) To carry food materials absorbed from the digestive tract to the tissue cells and to remove waste products for elimination by excretory organs—the kidneys, intestines, and skin.

(3) To carry hormones, which help regulate body functions, from ductless (endocrine) glands to the tissues of the body.

(4) To help regulate and equalize body temperature. Body cells generate large amounts of heat, and the circulating blood absorbs this heat.

(5) To protect the body against infection.

(6) To maintain the fluid balance in the body.

b. Composition of Blood. Blood is made up of a liquid portion, plasma, and formed elements, blood cells, suspended in the plasma.

(1) *Plasma.* Making up more than one-half of the total volume of blood, plasma is the carrier for blood cells and carbon dioxide and other dissolved wastes. It brings hormones and antibodies (protective substances) to the tissues. Other components of plasma are water, oxygen, nitrogen, fat, carbohydrates, and proteins. Fibrinogen, one of the plasma proteins, helps blood clotting. When blood clots, the liquid portion that remains is serum. Blood serum contains no blood cells.

vein in the body, extending from the foot to the groin. The saphenous vein has a long distance to lift blood against the force of gravity when an individual is in standing position. It is therefore susceptible to becoming dilated and stretched and the valves no longer function properly. When this occurs the vein is said to be varicosed.

2-37. Pulse and Blood Pressure

a. Pulse. This is a characteristic associated with the heartbeat and the subsequent wave of expansion and recoil set up in the wall of an artery. Pulse is defined as the alternate expansion and recoil of an artery. With each heartbeat, blood is forced into the arteries causing them to dilate (expand). Then the arteries contract (recoil) as the blood moves further along in the circulatory system. The pulse can be felt at certain points in the body where an artery lies close to the surface. The most common location for feeling the pulse is at the wrist, proximal to the thumb (radial artery) on the palm side of the hand. Alternate locations are in front of the ear (temporal artery), at the side of the neck (carotid artery), and on the top (dorsum) of the foot (dorsalis pedis).

b. Blood Pressure. The force that blood exerts on the walls of vessels through which it flows is called blood pressure. All parts of the blood vascular system are under pressure, but the term blood pressure usually refers to arterial pressure. Pressure in the arteries is highest when the ventricles contract during systole. Pressure is lowest when the ventricles relax during diastole. The brachial artery, in the upper arm, is the artery usually used for blood pressure measurement.

2-38. Lymphatic System

The lymphatic system consists of lymph, lymph vessels, and lymph nodes. The spleen belongs, in part, to the lymphatic system. Unlike the cardiovascular system, the lymphatic system has no pump to move the fluid which it collects, but muscle contractions and breathing movements aid in the movement of lymph through its channels and its return to the blood stream.

a. Lymph and Tissue Fluid. Lymph, fluid found in the lymph vessels, is clear and watery and is similar to tissue fluid, which is the colorless fluid that fills the spaces between tissues, between the cells of organs, and between cells and connective tissues. Tissue fluid serves as the "middleman" for the exchange between blood and body cells. Formed from plasma, it seeps out of capillary walls. The lymphatic system collects tissue fluid, and as lymph, the collected fluid is started on its way for return to the circulating blood.

b. Lymph Vessels. Starting as small blind ducts within the tissues, the lymphatic vessels enlarge to form lymphatic capillaries. These capillaries unite to form larger lymphatic vessels, which resemble veins in structure and arrangement. Valves in lymph vessels prevent backflow. Superficial lymph vessels collect lymph from the skin and subcutaneous tissue; deep vessels collect lymph from all other parts of the body. The two largest collecting vessels are the thoracic duct and the right lymphatic duct. The thoracic duct (fig. 2-22) receives lymph from all parts of the body except the upper right side. The lymph from the thoracic duct drains into the left subclavian vein, at the root of the neck on the left side. The right lymphatic duct drains into a corresponding vein on the right side.

c. Lymph Nodes. Occurring in groups up to a dozen or more, lymph nodes lie along the course of lymph vessels. Although variable in size, they are usually small oval bodies which are composed of lymphoid tissue. Lymph nodes act as filters for removal of infective organisms from the lymph stream. Important groups of these nodes are located in the axilla, the cervical region, the submaxillary region, the inguinal (groin) region, and the mesentric (abdominal) region.

d. Infection and the Lymphatic System. Lymph vessels and lymph nodes often become inflamed as the result of infection. An infection in the hand may cause inflammation of the lymph vessels as high as the axilla (armpit). Sore throat may cause inflammation and swelling of lymph nodes in the neck (submandibular nodes below the jaw and cervical nodes posteriorly).

e. Spleen. The largest collection of lymphoid tissue in the body, the spleen is located high in the abdominal cavity on the left side (LUQ), below the diaphragm and behind the stomach. It is somewhat long and ovoid (egg-shaped). Although it can be removed (splenectomy) without noticeable harmful effects, the spleen has useful functions, such as serving as a reservoir for blood and red blood cells.

2-39. The Blood

Blood is the red body fluid flowing through the arteries, capillaries, and veins. It varies in color are so numerous that there is at least one or more near every living cell. A single layer of endothelial cells forms the walls of a capillary. Capillaries are the essential link between arterial and venous circulation. The vital exchange of substances from the blood in the capillary with tissue cells takes place through the capillary wall. Blood starts its route back to the heart as it leaves the capillaries.

c. Veins. Veins have thin walls and valves. Formed from the inner vein lining, these valves prevent blood from flowing back toward the capillaries. Venules, the smallest veins, unite into veins of larger and larger size as the blood is collected to return to the heart. The superior vena cava, collecting blood from all regions above the diaphragm, and the inferior vena cava, collecting blood from all regions below the diaphragm, return the venous blood to the right atrium of the heart. Superficial veins lie close to the surface of the body and can be seen through the skin.

(1) The median basilic vein (fig. 2–21) (at the antecubital fossa in the bend of the elbow) is commonly used for venipuncture to obtain blood specimens or to inject solutions of drugs or parenteral fluid intravenously.

(2) The great saphenous vein is the longest

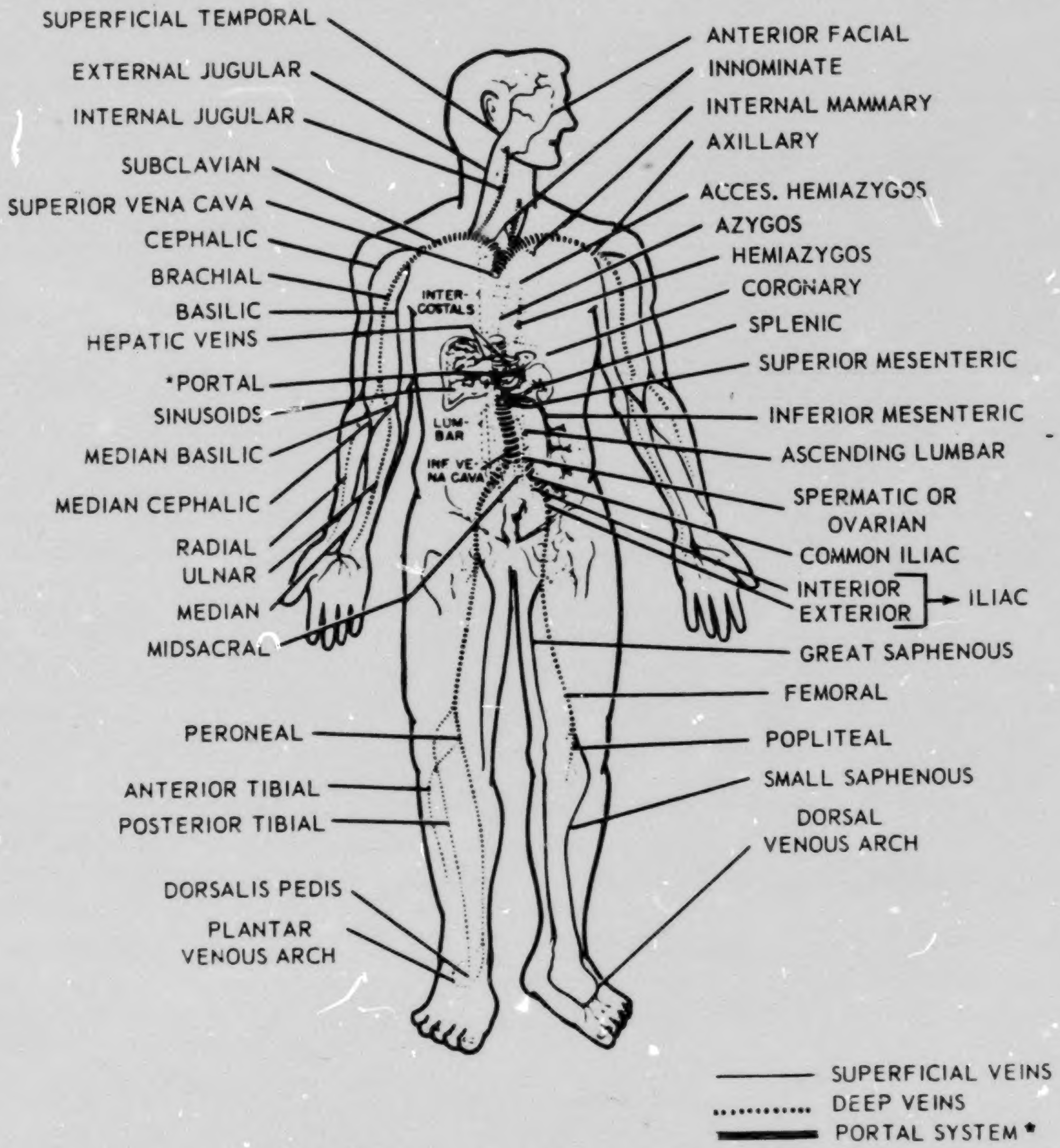
SUPERFICIAL TEMPORAL
EXTERNAL JUGULAR
INTERNAL JUGULAR
SUBCLAVIAN
SUPERIOR VENA CAVA
CEPHALIC
BRACHIAL
BASILIC
HEPATIC VEINS
*PORTAL
SINUSOIDS
MEDIAN BASILIC
MEDIAN CEPHALIC
RADIAL
ULNAR
MEDIAN
MIDSACRAL
PERONEAL
ANTERIOR TIBIAL
POSTERIOR TIBIAL
DORSALIS PEDIS
PLANTAR VENOUS ARCH
INTER-COSTALS
LUM-BAR
INF VE-NA CAVA
ANTERIOR FACIAL
INNOMINATE
INTERNAL MAMMARY
AXILLARY
ACCES. HEMIAZYGOS
AZYGOS
HEMIAZYGOS
CORONARY
SPLENIC
SUPERIOR MESENTERIC
INFERIOR MESENTERIC
ASCENDING LUMBAR
SPERMATIC OR OVARIAN
COMMON ILIAC
INTERIOR
EXTERIOR
ILIAC
GREAT SAPHENOUS
FEMORAL
POPLITEAL
SMALL SAPHENOUS
DORSAL VENOUS ARCH
SUPERFICIAL VEINS
DEEP VEINS
PORTAL SYSTEM *

Figure 2–21. Venous system (diagrammatic).

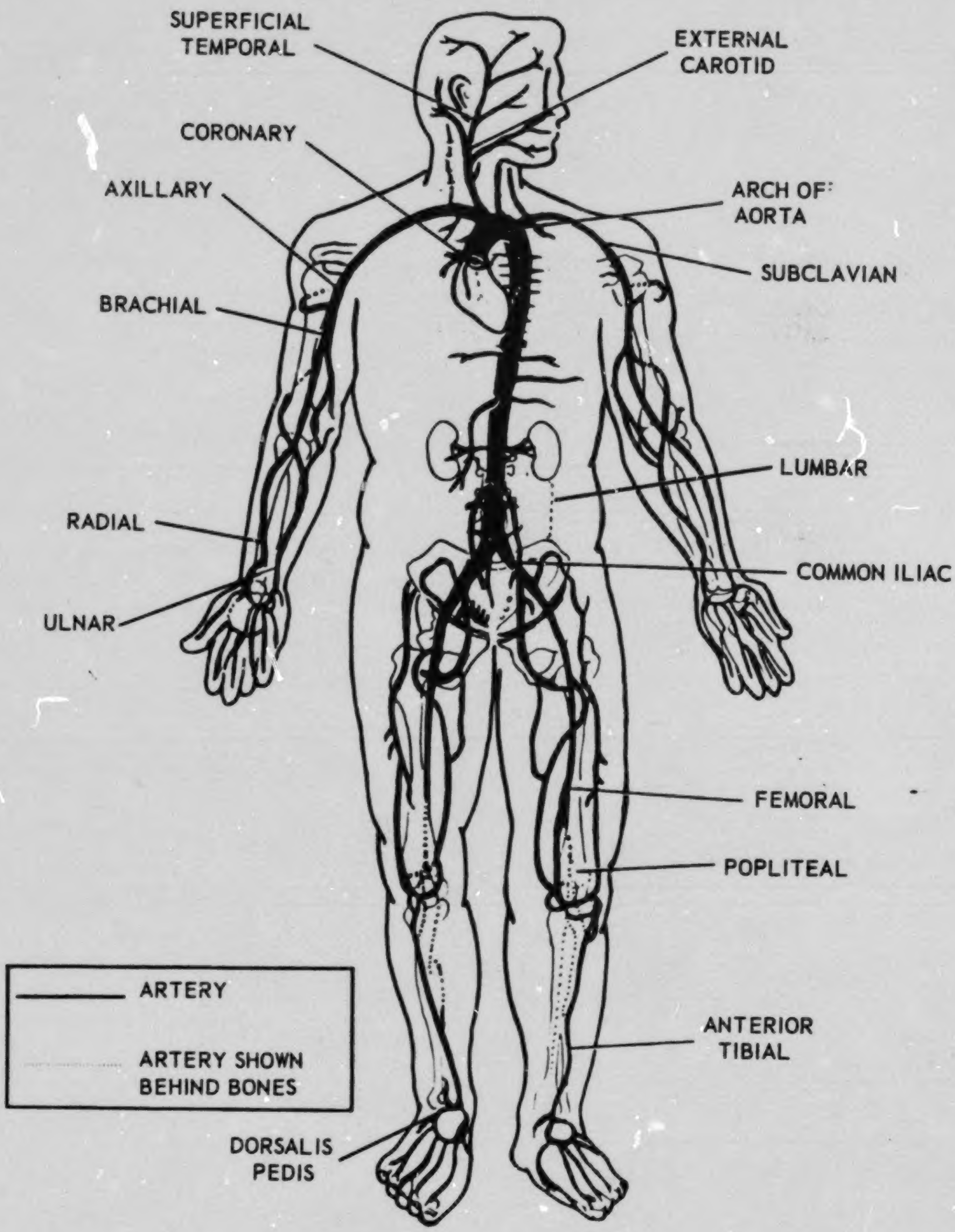
SUPERFICIAL TEMPORAL
EXTERNAL CAROTID
CORONARY
AXILLARY
ARCH OF AORTA
SUBCLAVIAN
BRACHIAL
LUMBAR
RADIAL
COMMON ILIAC
ULNAR
FEMORAL
POPLITEAL
ARTERY
ARTERY SHOWN BEHIND BONES
ANTERIOR TIBIAL
DORSALIS PEDIS

Figure 2-20. Arterial system (diagrammatic).

must often be controlled by clamping and tying off (ligating) the vessel. Some of the principal arteries and the area they supply with blood are—

(1) Carotid arteries, external and internal, supply the neck, head, and brain through their branches.

(2) Subclavian arteries supply the upper extremities.

(3) Femoral arteries supply the lower extremities.

b. Capillaries. Microscopic in size, capillaries

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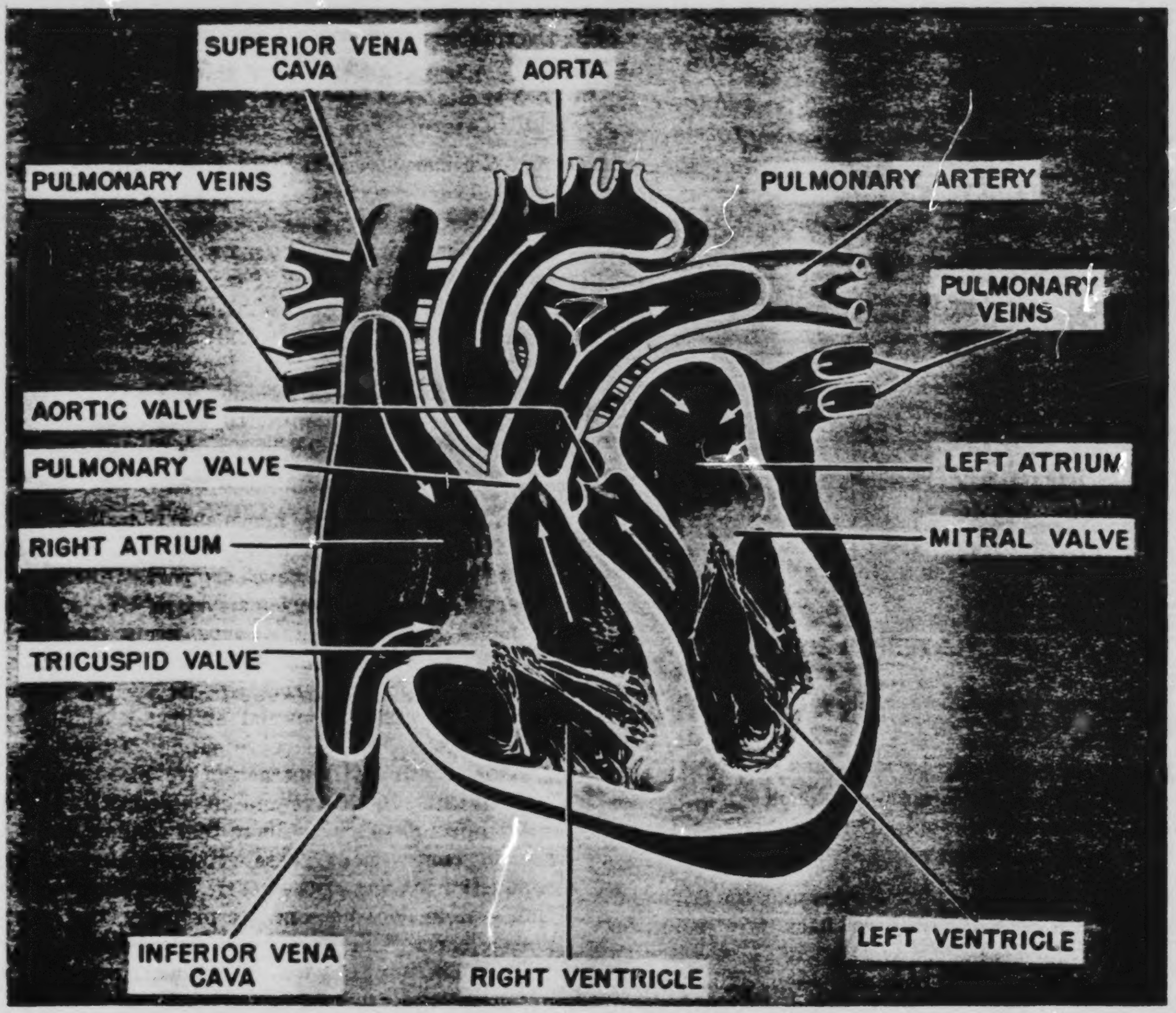
SUPERIOR VENA CAVA
AORTA
PULMONARY VEINS
PULMONARY ARTERY
PULMONARY VEINS
AORTIC VALVE
PULMONARY VALVE
LEFT ATRIUM
RIGHT ATRIUM
MITRAL VALVE
TRICUSPID VALVE
LEFT VENTRICLE
INFERIOR VENA CAVA
RIGHT VENTRICLE

Figure 2–19. The heart, chambers, and flow of blood.

and atrioventricular valves closing. The second, higher-pitched sound, "dup," is interpreted as the sound of the semilunar valves closing. The doctor listening to the heart sounds can detect alterations of normal sounds; the interpretation of these heart sounds is part of the diagnosis of heart disease.

2–36. Blood Vessels

The blood vessels are the closed system of tubes through which the blood flows. The arteries and arterioles are distributors. The capillaries are the vessels through which all exchange of fluid, oxygen, and carbon dioxide take place between the blood and tissue cells. The venules and veins are collectors, carrying blood back to the heart. The capillaries are the smallest of these vessels but are of greatest importance functionally in the circulatory system.

a. The Arteries and Arterioles. The system of arteries (fig. 2–20) and arterioles is like a tree, with the large trunk, the aorta, giving off branches which repeatedly divide and subdivide. Arterioles are very small arteries, about the diameter of a hair. By way of comparison, the aorta is more than 1 inch in diameter.) An artery wall has a layer of elastic, muscular tissue which allows it to expand and recoil. When an artery is cut, this wall does not collapse, and bright red blood escapes from the artery in spurts. Arterial bleeding

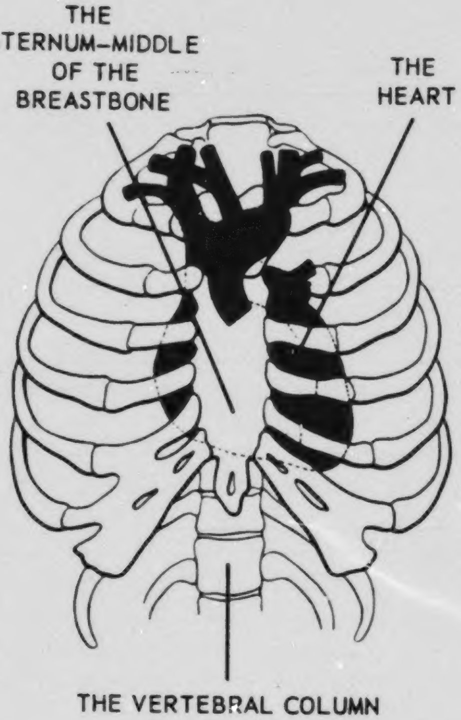

Figure 2-18. Heart and thoracic cage.

atrium. The right atrium contracts, and blood is forced through the open tricuspid valve into the relaxed right ventricle.

b. As the right ventricle contracts, the tricuspid valve is closed, preventing back flow into the atrium. The pulmonary semilunar valve opens as a result of the force and movement of the blood, and the right ventricle pumps the blood into the pulmonary artery.

c. The blood is carried through the lung tissues, exchanging its carbon dioxide for oxygen in the alveoli. This oxygenated blood is collected from the main pulmonary veins and delivered back to the left side of the heart to the left atrium.

d. As the left atrium contracts, the oxygenated blood flows through the open bicuspid (mitral) valve into the left ventricle.

e. As the left ventricle contracts, the bicuspid valve is closed. The aortic semilunar valve opens as a result of the force and movement of the blood, and the left ventricle pumps oxygenated blood through the aortic semilunar valve into the aorta, the main artery of the body. Oxygenated blood now starts its flow to all of the body cells and tissues. The systemic circulation starts from the left ventricle, the pulmonary circulation from the right ventricle.

2-34. Blood and Nerve Supply of the Heart

a. Coronary Arteries. The heart gets its blood supply from the right and left coronary arteries. These arteries branch off the aorta just above the heart, then subdivide into many smaller branches within the heart muscle. If any part of the heart muscle is deprived of its blood supply through interruption of blood flow through the coronary arteries and their branches, the muscle tissue deprived of blood cannot function and will die. This is called myocardial infarction. Blood from the heart tissue is returned by coronary veins to the right atrium.

b. Nerve Supply. The nerve supply to the heart is from two sets of nerves originating in the medulla of the brain. The nerves are part of the involuntary (autonomic) nervous system. One set, the branches from the vagus nerve, keeps the heart beating at a slow, regular rate. The other set, the cardiac accelerator nerves, speeds up the heart. Heart muscle has a special ability: it contracts automatically, but the nerve supply is needed to provide an effective contraction for blood circulation. Within the heart muscle itself, there are special groups of nerve fibers that conduct impulses for contraction. These groups make up the conduction system of the heart. When the conduction system does not operate properly, the heart muscle contractions are uncoordinated and ineffective. The impulses within the heart muscle are minute electric currents, which can be picked up and recorded by the electrocardiogram, the ECG.

2-35. The Heartbeat and Heart Sounds

a. Heartbeat. This is a complete cycle of heart action—contraction, or systole, and relaxation, or diastole. During systole, blood is forced from the chambers. During diastole, blood refills the chambers. The term cardiac cycle means the complete heart beat. The cardiac cycle, repeated continuously at a regular rhythm, occurs 70-80 times per minute. Each complete cycle takes less than one second—in this brief time, all of the heart action needed to move blood must take place, and the heart must be ready to repeat its cycle.

b. Heart Sounds. When heard through a stethoscope, heart sounds are described as "lubb-dup." The first sound, "lubb," is interpreted as the sound, or vibration, of the ventricles contracting

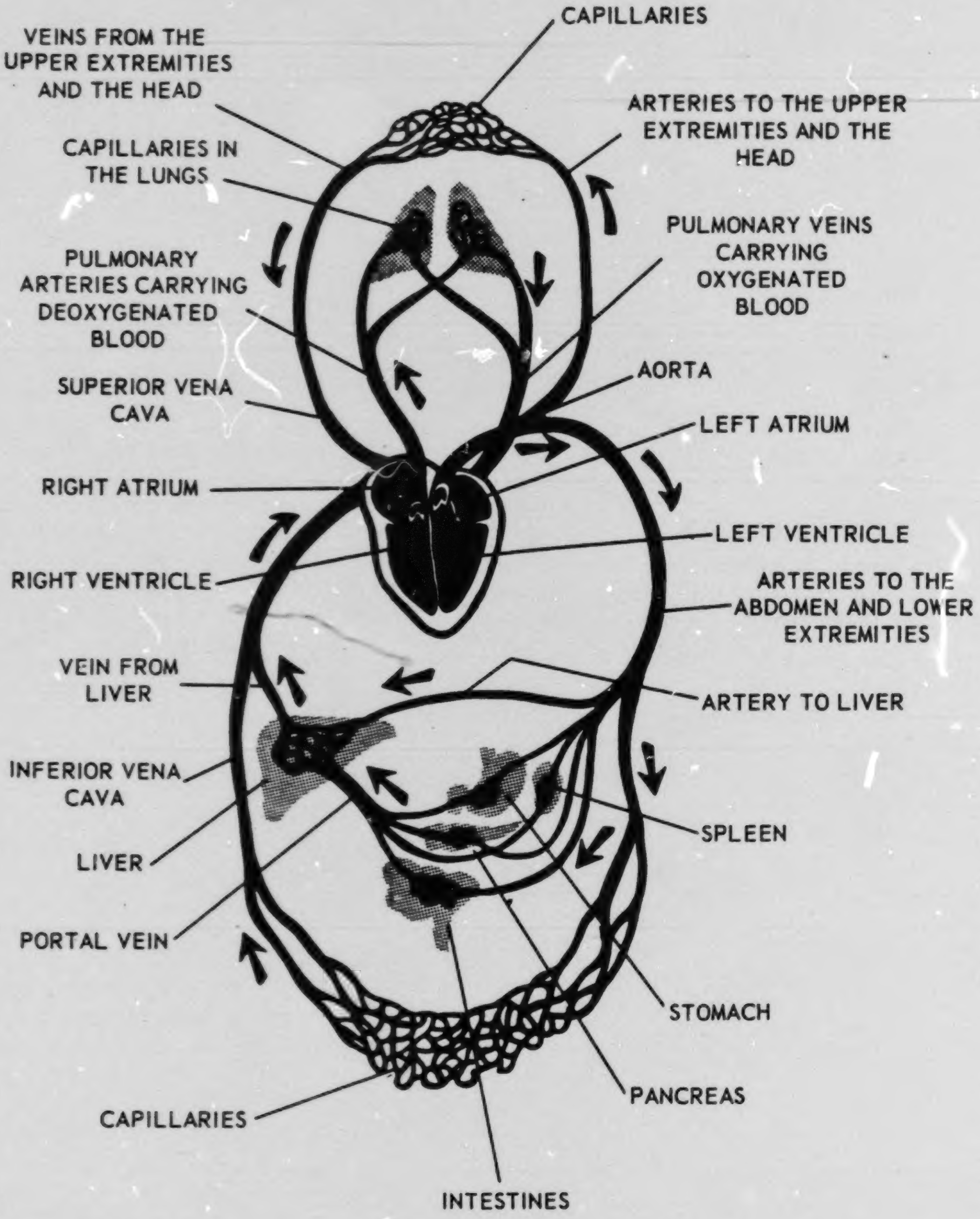
CAPILLARIES
VEINS FROM THE UPPER EXTREMITIES AND THE HEAD
ARTERIES TO THE UPPER EXTREMITIES AND THE HEAD
CAPILLARIES IN THE LUNGS
PULMONARY VEINS CARRYING OXYGENATED BLOOD
PULMONARY ARTERIES CARRYING DEOXYGENATED BLOOD
AORTA
SUPERIOR VENA CAVA
LEFT ATRIUM
RIGHT ATRIUM
LEFT VENTRICLE
RIGHT VENTRICLE
ARTERIES TO THE ABDOMEN AND LOWER EXTREMITIES
VEIN FROM LIVER
ARTERY TO LIVER
INFERIOR VENA CAVA
SPLEEN
LIVER
PORTAL VEIN
STOMACH
PANCREAS
CAPILLARIES
INTESTINES

Figure 2–17. Circulation of the blood (diagrammatic).

of the heart structures. Remember, the heart is the pump and is also the connection between the systemic circulation and pulmonary circulation. All the blood returning from the systemic circulation must flow through the pulmonary circulation for exchange of carbon dioxide for oxygen. Blood from the upper part of the body enters the heart through a large vein, the superior vena cava, and from the lower part of the body by the inferior vena cava (fig. 2–19).

a. Blood from the superior vena cava and inferior vena cava enters the heart at the right by controlling heat loss in two different ways. Blood vessels in the dermis can change size. *For example,* when blood vessels are dilated, warm blood is closer to the skin surface, and heat is lost more rapidly. When blood vessels constrict, the amount of blood at the skin surface is decreased, and heat is conserved. Because the surface of the skin is so large, heat loss by radiation is considerable. Added to this heat loss by radiation is the heat loss by evaporation of sweat. In very humid weather, evaporation of sweat from the skin and from saturated clothing decreases.

Section VI. THE CIRCULATORY SYSTEM

2-31. Introduction

The circulatory system has two major fluid transportation systems, the cardiovascular and the lymphatic.

a. Cardiovascular System. This system, which contains the heart and blood vessels, is a closed system, transporting blood to all parts of the body. Blood flowing through the circuit formed by the heart and blood vessels (fig. 2-17) brings oxygen, food, and other chemical elements to tissue cells and removes carbon dioxide and other waste products resulting from cell activity.

b. Lymphatic System. This system, which provides drainage for tissue fluid, is an auxiliary part of the circulatory system, returning an important amount of tissue fluid to the blood stream through its own system of lymphatic vessels.

2-32. The Heart

The heart, designed to be a highly efficient pump, is a four-chambered muscular organ, lying within the chest, with about ⅔ of its mass to the left of the midline (fig. 2-18). It lies in the pericardial space in the thoracic cavity between the two lungs. In size and shape, it resembles a man's closed fist. Its lower point, the apex, lies just above the left diaphragm.

a. Heart Covering. The pericardium is a double-walled sac inclosing the heart. The outer fibrous surface gives support, and the inner lining prevents friction as the heart moves within its protecting jacket. The lining surfaces of the pericardial sac produce a small amount of pericardial fluid needed for lubrication to facilitate the normal movements of the heart.

b. Heart Wall. This muscular wall is made up of cardiac muscle called myocardium.

c. Heart Chambers. There are four chambers in the heart. These chambers are essentially the same size. The upper chambers, called the atria, are seemingly smaller than the lower chambers, the ventricles. The apparent difference in total size is due to the thickness of the myocardial layer. The right atrium communicates with the right ventricle; the left atrium communicates with the left ventricle. The septum (partition), dividing the interior of the heart into right and left sides, prevents direct communication of blood flow from right to left chambers or left to right chambers. This is important, because the right side of the heart receives deoxygenated blood returning from the systemic (body) circulation. The left side of the heart receives oxygenated blood returning from the pulmonary (lung) circulation. The special structure of the heart keeps the blood flowing in its proper direction to and from the heart chambers.

d. Heart Valves. The four chambers of the heart are lined with endocardium. At each opening from the chambers this lining folds on itself and extends into the opening to form valves. These valves allow the blood to pass from a chamber but prevent its return. The atrioventricular valves, between the upper and lower chambers, are within the heart itself. The semilunar valves are within arteries arising from the right and left ventricles.

(1) *Atrioventricular valves.* The tricuspid valve is located between the right atrium and right ventricle. It has three flaps or cusps. The bicuspid valve or mitral valve is located between the left atrium and left ventricle. It has two flaps or cusps.

(2) *Semilunar valves.* The pulmonary semilunar (half-moon shaped) valve is located at the opening into the pulmonary artery that arises from the right ventricle. The aortic semilunar valve is located at the opening into the aorta that arises from the left ventricle.

2-33. Flow of Blood Through the Heart

It is helpful to follow the flow of blood through the heart in order to understand the relationship

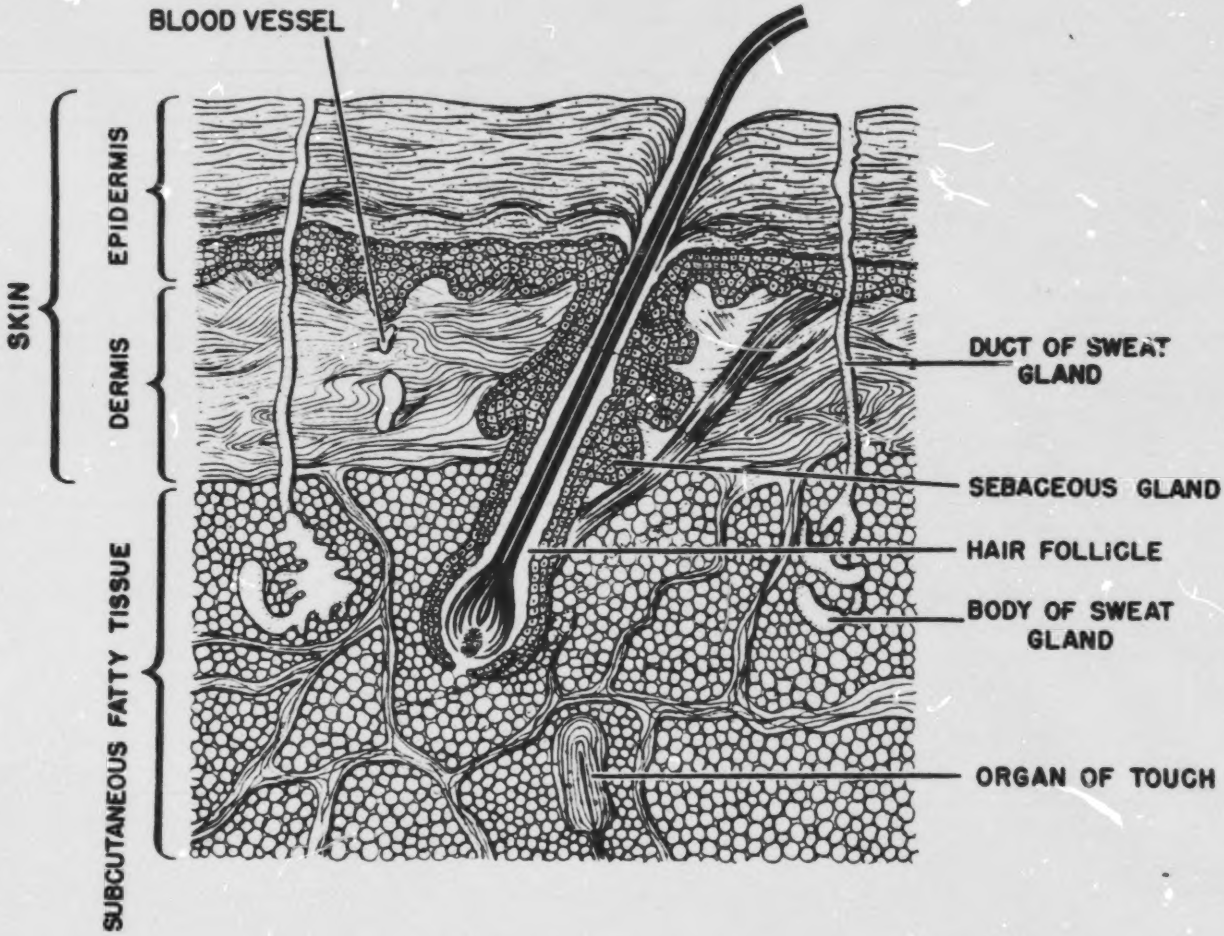

Figure 2-16. Structure of the skin.

b. The dermis is the deep, true skin layer. Nerves, blood vessels, glands, hair roots, and nail roots are in the dermis, supported by a connective tissue meshwork of elastic fibers. Tiny involuntary muscle fibers in the dermis contract and account for the reactions described as "hair standing on end" and "goose pimples."

c. The subcutaneous layer of tissue beneath the dermis is not skin. It is superficial fascia, a connective tissue. Fat and other connective tissues in the subcutaneous layer round out body surfaces and cushion bony parts. When a hypodermic injection is given, it is given into the subcutaneous tissue, below the skin layers.

2-29. Skin Accessory Organs

Hair, nails, sebaceous (oil) glands, and sweat glands are skin accessory organs. Each hair grows from a root embedded in the dermis, or below the dermis. A little tube, the hair follicle, incloses the root. Fingernails and toenails grow from nail beds buried at the proximal ends of the nails. The sebaceous glands secrete an oil called sebum, which lubricates the hair and the skin surface. This oily secretion keeps the skin pliable and helps keep it waterproof. When the openings of the sebaceous glands become plugged with dirt, they form blackheads. Sweat glands manufacture sweat, or perspiration, from fluid drawn from the blood. Sweat contains salts and organic wastes and is about 99 percent water. It is discharged through skin openings called the pores. As sweat evaporates, the body is cooled. Sweat formation and excretion is an important mechanism for losing body heat.

2-30. Skin as a Temperature Regulator

Skin helps regulate the temperature of the body

(2) The biceps, a long, two-headed muscle located on the anterior arm, flexes the forearm at the elbow. It also helps to turn the arm palm up in supination.

(3) The triceps, a large three-headed muscle located on the posterior arm, extends the forearm at the elbow.

e. Back. The muscles of the back are large, and some are broad. Attached to vertebrae, the back muscles keep the trunk in an erect posture and aid it in bending and rotating. In the thoracic region, these muscles assist in respiration and in movements of the neck, arm, and trunk. Although the muscles of the midback are very powerful, the thigh and buttock muscles should be used in lifting to avoid straining the bony and ligamentous structures of the back.

f. Abdominal. The abdominal muscles form broad, thin layers which support the internal abdominal organs, assist in respiration, and help in flexion and rotation of the spine. Their names indicate their line of pull—external oblique, rectus abdominis (straight up and down), and transverse. Abdominal muscles also assist in urination and in defecation.

g. Perineal. The muscles of the perineum form the floor of the pelvic cavity and aid in defecation and in urination.

h. Buttocks. The thick, strong muscles of the buttocks help to stabilize the hip, and with the muscles of the posterior thigh, distribute weight to the pelvis in lifting and relieve the strain on the back muscles. This gluteus group includes the gluteus maximus, gluteus medius, and gluteus minimus. These muscles extend and rotate the thigh.

i. Thigh. The muscles located on the anterior and posterior of the thigh cross two joints, the hip and the knee. When they contract, they extend one joint and flex the other. The anterior thigh muscles include the quadriceps femoris and the posterior ones include the biceps femoris.

(1) *Quadriceps femoris.* This four-headed group of muscles located on the anterior of the thigh extends the leg at the knee. Its four muscles are the vastus lateralis, rectus femoris, vastus intermedius, and vastus medialis.

(2) *Biceps femoris* (*hamstring group*). This muscle group on the posterior of the thigh flexes the knee and extends the thigh.

j. Leg. The anterior muscle group of the leg includes the anterior tibialis, which flexes the foot on the leg, turning the foot upward in dorsiflexion. The largest posterior muscle of the leg is the gastrocnemius, the calf muscle, which attaches to the heel through the Achilles tendon. Contraction of the gastrocnemius causes the foot to turn downward in plantar flexion, or foot drop.

Section V. THE SKIN

2–27. Integumentary System and Its Functions

The skin is called the integumentary or covering body system and serves the body in many important ways. The most obvious feature of skin is its outward appearance; indeed, the appearance and feel of the skin are important indications of general health and hygiene. Four functions of skin are protection, as a mechanical barrier to the entrance of bacteria; regulation of body temperature, through control of heat loss; sensory perception, through nerve endings that transmit sensations of touch, heat, cold, and pain; and excretion of body wastes, through sweat. Although this is not one of its normal functions, the skin can absorb water and other substances. This property of the skin is used to advantage in prescribing local application of certain drugs. It can be harmful, too, as when toxic agents such as "G" gas, lead salts in gasoline, and insecticides are absorbed and permitted to enter the body through the skin.

2–28. Structure

The skin has two principal layers, the epidermis, or outer layer, and the dermis, the inner layer or true skin. The epidermis and dermis (fig. 2–16) are supported by a subcutaneous (under-the-skin) layer which connects the skin to underlying muscles.

a. There are no blood vessels or nerve endings in the epidermis, which has two layers, outer and inner. The outer layer has flat, scaly, lifeless cells that are constantly being worn off by surface contacts. As this is happening, rapidly growing inner epidermis cells push up and replace the top layers. Skin pigment, found in the deepest parts of these inner epidermis cells, varies in individuals. It determines the darkness or lightness of skin color. However, the color of the skin is also due to the quantity and state of the blood circulating in the dermis, the inner skin layer. Pinkness, blueness (cyanosis), or pallor (paleness) of the skin surface is due to circulating blood.

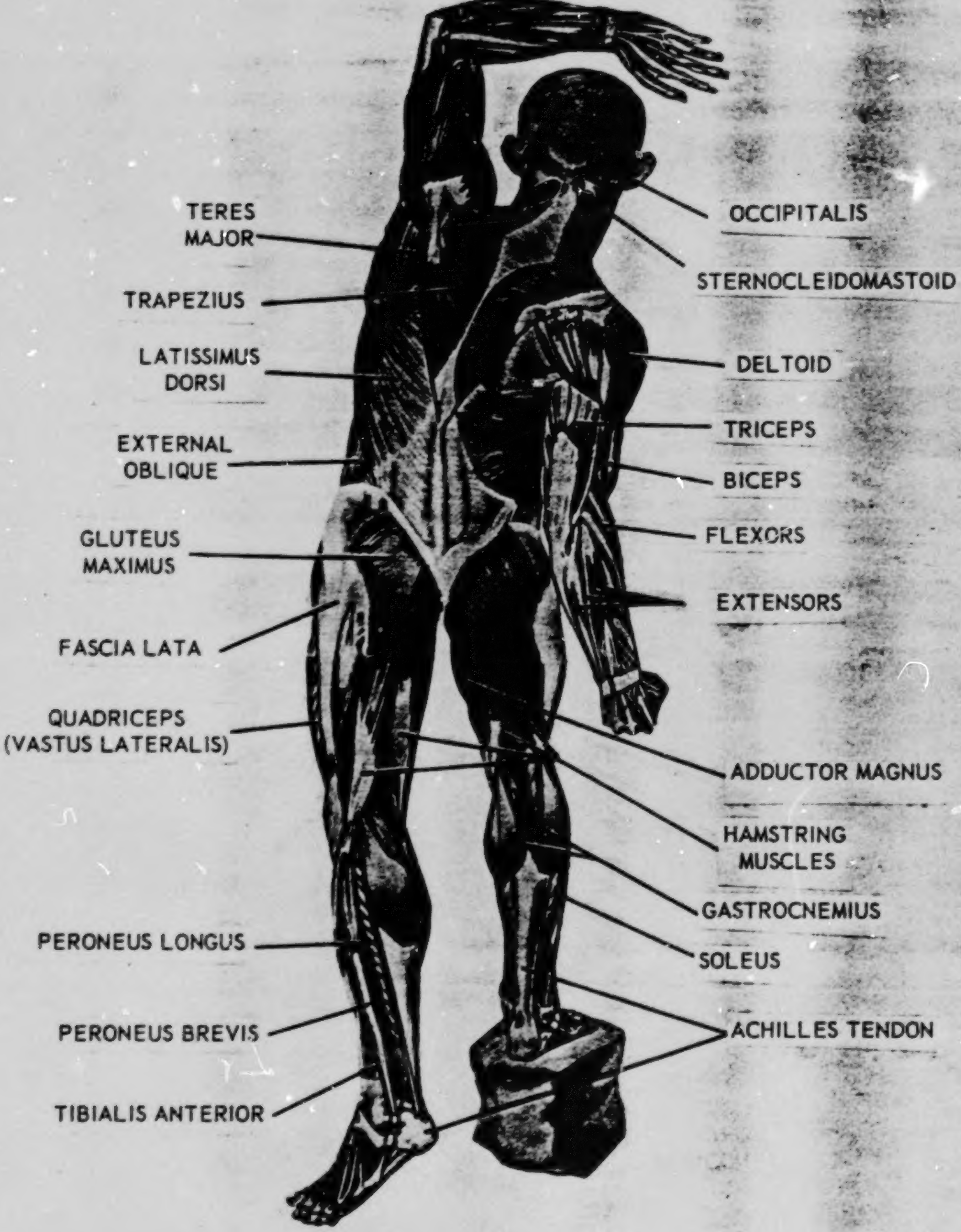
TERES MAJOR
TRAPEZIUS
LATISSIMUS DORSI
EXTERNAL OBLIQUE
GLUTEUS MAXIMUS
FASCIA LATA
QUADRICEPS (VASTUS LATERALIS)
PERONEUS LONGUS
PERONEUS BREVIS
TIBIALIS ANTERIOR
OCCIPITALIS
STERNOCLEIDOMASTOID
DELTOID
TRICEPS
BICEPS
FLEXORS
EXTENSORS
ADDUCTOR MAGNUS
HAMSTRING MUSCLES
GASTROCNEMIUS
SOLEUS
ACHILLES TENDON

Figure 2-15—Continued.

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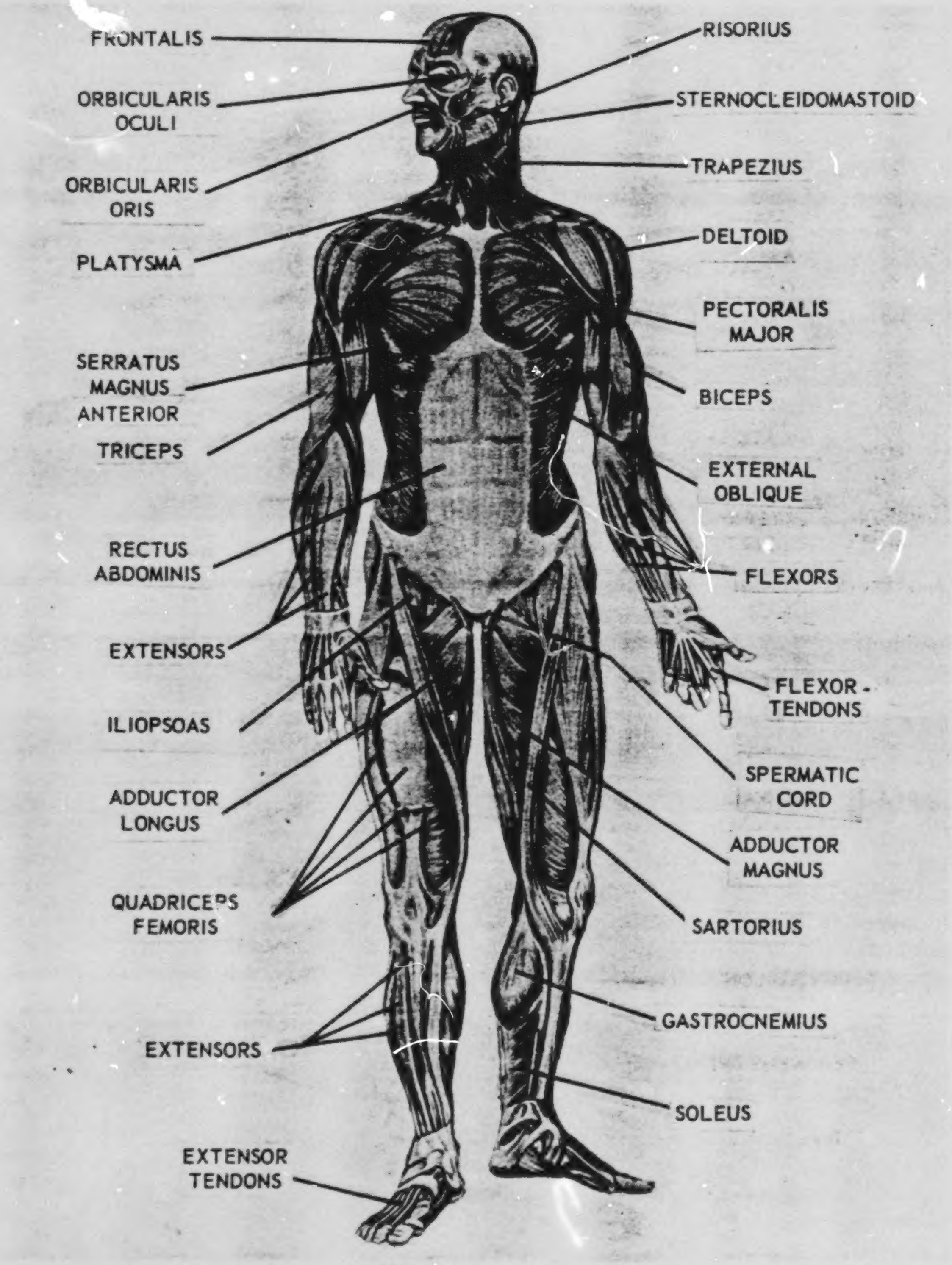
FRONTALIS
ORBICULARIS OCULI
ORBICULARIS ORIS
PLATYSMA
SERRATUS MAGNUS ANTERIOR
TRICEPS
RECTUS ABDOMINIS
EXTENSORS
ILIOPSOAS
ADDUCTOR LONGUS
QUADRICEPS FEMORIS
EXTENSORS
EXTENSOR TENDONS
RISORIUS
STERNOCLEIDOMASTOID
TRAPEZIUS
DELTOID
PECTORALIS MAJOR
BICEPS
EXTERNAL OBLIQUE
FLEXORS
FLEXOR - TENDONS
SPERMATIC CORD
ADDUCTOR MAGNUS
SARTORIUS
GASTROCNEMIUS
SOLEUS

Figure 2-15. Superficial muscles.

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muscles. At the midline of the abdomen, where there are no bones for muscles to attach to, abdominal muscles to the left and right of the midline are attached to central aponeuroses.

b. Muscle Movements. When muscle fibers are stimulated to contract by an impulse received from a motor nerve, the muscle shortens and pulls against its connective tissue attachment. One attachment is sometimes a fixed joint or anchor, and the direction of motion is then toward it. The power of the muscle contraction is transmitted to the bone or to an adjacent muscle, and movement occurs.

c. Muscle Tone. Healthy muscle is characterized by active contraction in response to the reaction of the nervous system to the environment. This readiness to act (resulting in firing of motor units) as stimuli from the environment impinge upon the nervous system is called muscle tone. Muscles that have lost their tone through lack of exercise, through primary muscle disease, or through nerve damage become flabby (flaccid). The tone of muscles is due to the constant, steady contraction and relaxation of different muscle fibers in individual muscles, which helps to maintain the "chemical engine" of the muscle cells. Even minor exercise movements help maintain tone by renewing blood supply to muscle cells. Wriggling the toes, flexing and extending the fingers, changing the depth of respirations, turning and repositioning the body are examples of exercises that help restore and maintain muscle tone.

d. Muscle Activity. Muscle contraction consumes food and oxygen and produces acids and heat. Muscle activity is the major source of the body's heat. Acids accumulating as a result of continued activity cause fatigue, which occurs most rapidly when contractions are frequent. It occurs slowly if rest periods are taken between contractions. Exercise causes muscles to become larger, stronger, and better developed. An increase in muscle size is hypertrophy; wasting away of muscles due to inactivity is atrophy. Physical exercise is necessary to keep muscles in good condition.

2-25. Principles of Skeletal Muscle Action

A few general principles about skeletal muscle action should be understood. The three principles listed will help associate muscle actions with normal body movements and patient care activities.

a. Muscles produce movements by pulling on bones. Since bones move at joints, most muscles attach to bones above and below a joint. One bone is stabilized while the other bone moves.

b. Muscles moving a part usually lie proximal to the part moved. *For example,* muscles moving the humerus are in the shoulder, chest, and back; muscles moving the femur are in the lumbar and pelvic region.

c. Muscles almost always act in groups rather than singly. The coordinated action of several muscles produces movement—while one group contracts, the other group relaxes, and vice versa. The muscle whose contraction produces the movement is the prime mover. The muscle which relaxes is the antagonist. In bending (flexing) and stretching (extending) the forearm, the biceps and triceps in the upper arm are, alternately, prime movers and antagonists.

2-26. Principal Groups of Skeletal Muscles

Since there are more than 400 individually named skeletal muscles, only a few will be discussed in this manual. In figure 2-15, both Ⓐ and Ⓑ illustrate the general location of the muscles discussed. Muscles are usually named for one or more features such as their location, action, shape, or points of attachment.

a. Head and Face. Muscles of the head and face act in movements of the eye, facial expressions, talking, chewing, and swallowing. The orbicularis oculi closes the eyelid; the orbicularis oris closes the lips; the masseter closes the jaw and clamps the back teeth together.

b. Neck. The muscles of the neck move the head from side to side, forward and backward, and rotate it. Some also assist in respiration, speaking, and swallowing. The sternocleidomastoid bends the head forward and helps turn it to either side.

c. Chest. The strong chest muscles move the arm, brace the shoulder, and compress the chest for effective coughing. The diaphragm, the major muscle of respiration, separates the thoracic and abdominal cavities. (It is not shown in the diagram of superficial skeletal muscles.) The pectoralis major draws the upper arm forward across the chest. The latimus dorsi and trapezius are major muscles of the posterior thorax.

d. Arm. Among the muscles which cause movement of the arms are the deltoid, biceps, and triceps. (The extensors and flexors cause hand and finger movements.)

(1) The deltoid is a triangular-shaped muscle, capping the shoulder and upper arm. The deltoid lifts the arm forward, sideways, and to the rear.

backward movement—the posterior bone surfaces approach each other.

(3) Pivot joints, as at the head and neck, at the first and second cervical vertebrae. The distal ends of the radius and ulna also form a pivot joint for rotation of the wrist.

2-21. Joints and Bursae

At some joint locations, the tendon connecting muscle to bone passes over a joint; *for example*, at the shoulder, elbow, knee, and heel. To reduce pressure, small sacs containing fluid are formed over and around the tendon. The sac is a bursa, and an irritated bursa is bursitis. The knee has four bursae, over and around the patella. When domestic chores included scrubbing floors on hands and knees, inflammation of the knee bursae was called "housemaid's knee." Bursitis can be very painful, and normal movement may be impossible.

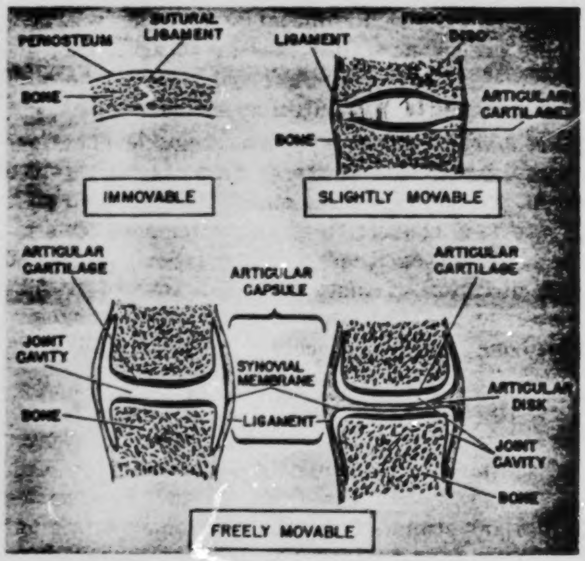

Figure 2-14. Types of joints.

Section IV. THE SKELETAL MUSCULAR SYSTEM

2-22. Muscles

The muscles of the body include the smooth muscle in the walls of internal organs, the cardiac muscle in the walls of the heart, and the skeletal muscle attached to and causing movements of bones. Muscles have the ability to contract, and it is this power of muscle contraction that produces body movements. The skeletal muscles and their action and movements on bones and joints will be discussed in this section.

2-23. Skeletal Muscles

Although skeletal muscles are called voluntary muscles, they require a functioning nerve supply and something to pull against for normal contraction. It is important to think of skeletal muscles as one part of a three-part, neuro-muscular-skeletal unit. *For example*, a functioning nerve supply (a motor nerve from the central nervous system) is needed to stimulate muscle contraction; the muscle itself must be able to contract and to relax; and the power of the muscle contraction must be transmitted to a bone, or other attachment, to produce the desired movement. When any one part of this three-part unit cannot function normally, the other two parts also lose their ability to function normally. When all three parts—nerve, muscle, and bone—are intact, the many movements associated with skeletal muscles are possible. Skeletal muscle movements include locomotion, or moving from place to place; rhythmic breathing movements; blinking of eyelids; position changes; chewing and swallowing; coughing; and changes in facial expression. Many of these movements are essential for survival.

2-24. Muscle Structure and Muscle Movements

Long, slender muscle cells form fibers; muscle fibers are grouped together into bundles; and muscle bundles are grouped together to form an individual skeletal muscle. Each skeletal muscle is wrapped in a connective tissue sheath, a form of fascia. This muscle sheath incloses the blood vessels and nerves that stimulate and nourish the muscle cells. The connective tissue parts are opaque, or whitish, in color, while the muscle bundles are the lean, red-meat part of muscles. Individual muscles differ considerably in size, shape, and arrangement of muscle fibers. The fiber arrangement determines the line of pull of an individual muscle.

a. Muscle Attachments. Extensions of muscle sheath become continuous with tough connective tissue attachments such as tendons or aponeuroses that bind muscles to bones or to adjacent muscles. Tendons are cordlike attachments of connective tissue that unite with the periosteum of bone. Aponeuroses are broad, sheetlike attachments which can unite with muscle sheaths of adjacent

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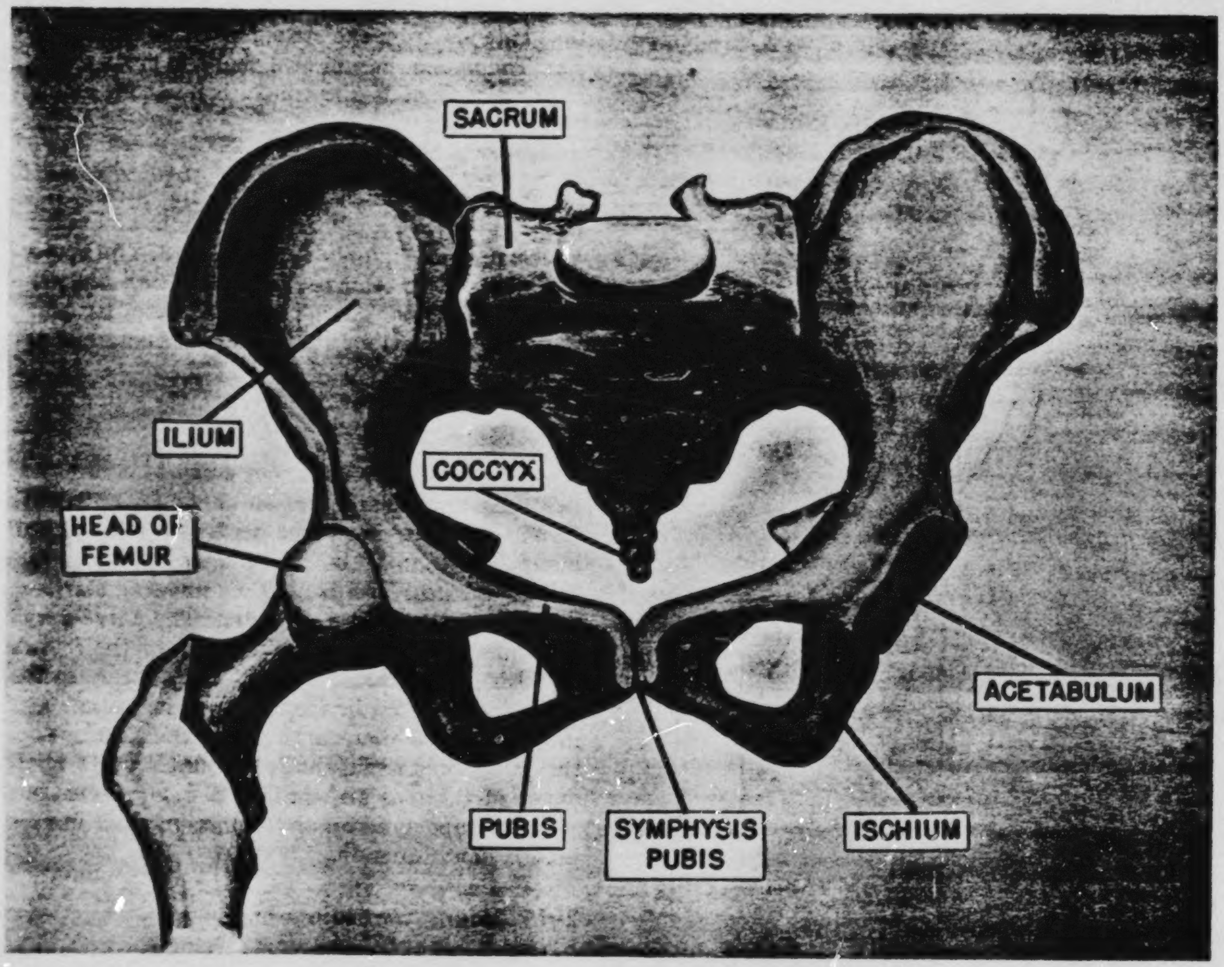


Figure 2-13. Pelvis.

strong fibrous connective tissue bands that hold the bones together at the joint. In some joints, the ligaments enclose the joint, forming the joint capsule.

d. Some joint disorders are mechanical—the parts of the joint are displaced or dislocated. Another term for a type of dislocation is "subluxation," a partial displacement of one bone surface within the joint. When the ligaments holding the joint together are partially torn, but the joint is not displaced, the injury is called a sprain.

2-20. Joint Movements

a. Movable joints allow change of position and motion. Examples of joint movement (app. B) are flexion (bending), extension (straightening), abduction (movement away from the midline), and adduction (movement toward the midline), pronation (turning the forearm so that the palm of the hand is down), and supination (turning the forearm so that the palm of the hand is up).

b. Attempts to force joints to move beyond their normal limitations can be disastrous. The structure of the joint determines the kind of movement that is possible, since the bone ends reciprocate, or fit into each other, at the joint. Examples of joint structure that permit certain kinds of joint movement include:

(1) Ball and socket joints, as in the shoulder and hip. These joints permit the widest range of motion—flexion, extension, abduction, adduction, and rotation.

(2) Hinge joints, as in the elbow and knee. Hinge joints permit flexion and extension. Elbow joints have forward movement—the anterior bone surfaces approach each other. Knee joints have

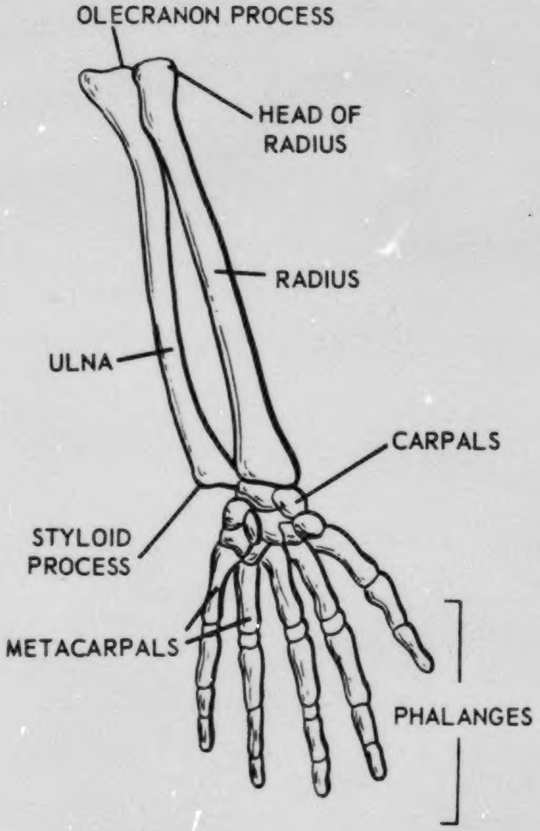


Figure 2-12. Forearm and hand.

upper part of the hip. The iliac crests, the upper ridges of the ilium, are important landmarks. The ischium is the lower, posterior portion on which one sits. The pubis is the anterior portion of the hip. A deep, cup-shaped socket, the acetabulum, is located on the lower lateral surface of each hip bone. The cup shape of the acetabulum fits the head of the femur to form the hip joint.

b. The femur or thigh bone (fig. 2-7) is the longest, strongest bone in the body. The head of the femur fits into the acetabulum of the hip bone. The neck of the femur, just below the head, is the part most frequently fractured, particularly by elderly individuals. The distal end of the femur articulates with the tibia, to form the knee joint. A large prominent projection at the junction of the shaft and neck of the femus is the trochanter, which is an important attachment for strong thigh muscles.

c. The patella, or knee cap, is the bone protecting the front of the knee joint. It is a special kind of bone embedded within the powerful tendon that extends from the strong anterior thigh muscles. The patella has an oval shape in cross section and is classified as a sesamoid bone (bone embedded in tendons).

d. The tibia and fibula are the two bones in the leg. The tibia, which is thicker and stronger, is the shin bone. It supports body weight and articulates with the femur in the knee joint. The projection at its lower end is the medial malleolus, the inner ankle bone. The fibula, the lateral leg bone, is joined to the tibia at its proximal end, but not to the femur. The projection at the distal end of the fibula is the lateral malleolus, the outer ankle bone.

e. The skeleton of the foot consists of the tarsals, metatarsals, and the phalanges. Seven tarsals form the ankle, heel, and posterior half of the instep. The talus is the largest ankle bone, and the calcaneus is the heel bone. Five metatarsals form the anterior half of the instep. The tarsals and metatarsals together form the arch of the foot, a structure important in weight distribution to the foot. Tendons and ligaments hold the tarsals and metatarsals in their arched position, and when this support is weak, the foot is flat. The 14 phalanges of the toes are similar to finger bones but are less important for foot function than fingers are for hand function.

2-19. Joints (Articulations)

A joint is a structure which holds together separate bones. Joints are classified according to the amount of movement they permit—immovable, slightly movable, and freely movable (fig. 2-14).

a. Immovable joints have bone surfaces fused together to prevent motion. At one time during skeletal development, these joints had some movement but as the bones matured they grew together for stability. The pelvic girdle, sacral and coccygeal vertebrae, and skull bones are examples of immovable joints.

b. Slightly movable joints have cartilage discs between bones and are held in place by strong ligaments. The cartilage permits some give, and ligaments prevent bone separation. Vertebral bodies and the symphysis pubis are examples of slightly movable joints.

c. Freely movable joints permit maximum motion. These joints have a more complex arrangement since they have joint cavities. The several parts of a joint cavity include the joint capsule, the capsule lining (synovial membrane), and some lubricating fluid within the cavity. Ligaments are

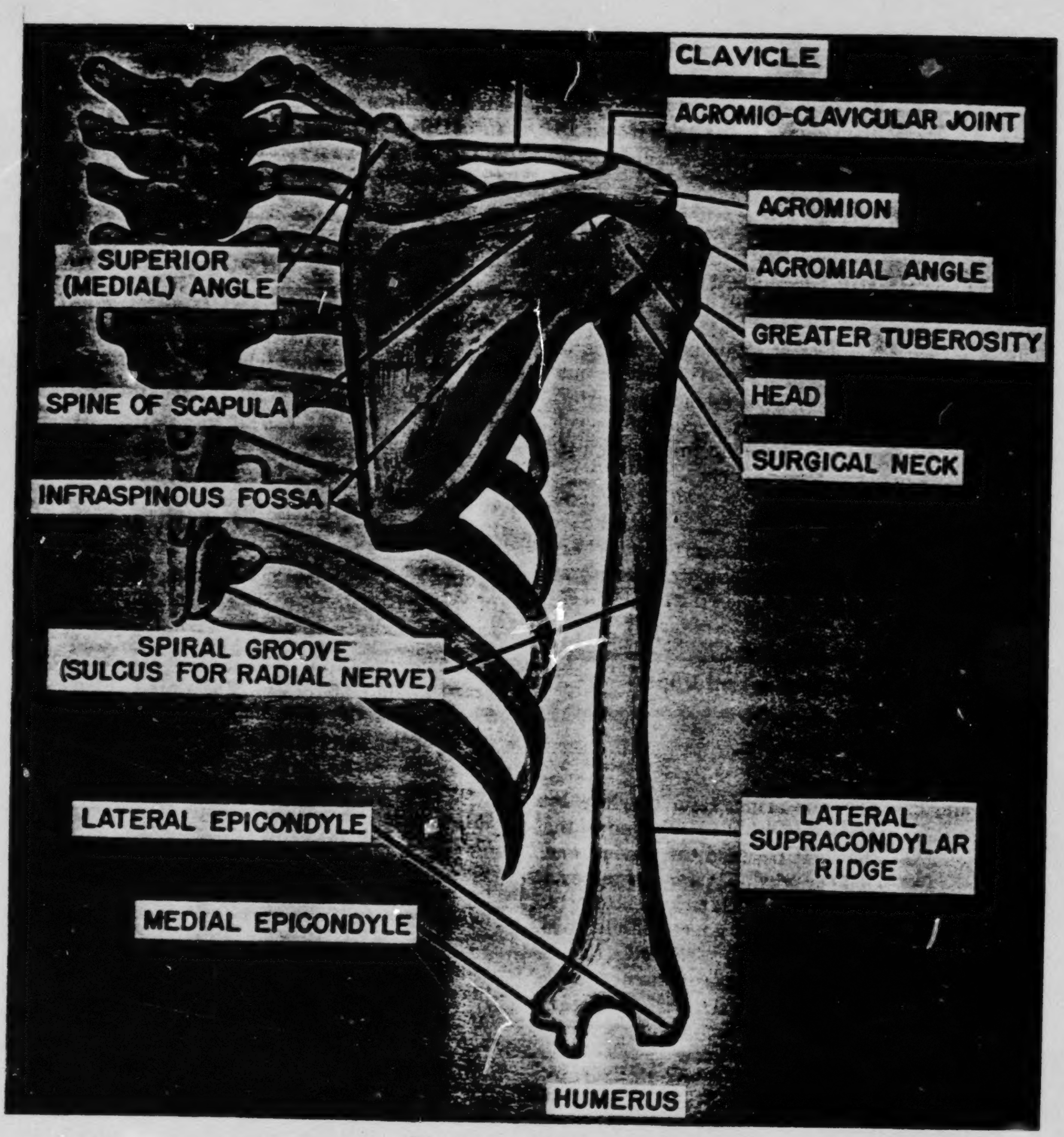

CLAVICLE
ACROMIO-CLAVICULAR JOINT
ACROMION
ACROMIAL ANGLE
GREATER TUBEROSITY
HEAD
SURGICAL NECK
SUPERIOR (MEDIAL) ANGLE
SPINE OF SCAPULA
INFRASPINOUS FOSSA
SPIRAL GROOVE (SULCUS FOR RADIAL NERVE)
LATERAL EPICONDYLE
LATERAL SUPRACONDYLAR RIDGE
MEDIAL EPICONDYLE
HUMERUS

Figure 2–11. Shoulder girdle.

and lower extremity are the os coxa (hip bone), femur (thigh bone), patella (knee cap), tibia and fibula (leg bones), tarsals (ankle bones), metatarsals (foot bones), and phalanges (toe bones) (fig. 2–6). In contrast to the shoulder girdle, the pelvic girdle is inflexible and very strong (for weight bearing).

a. The hip bone is formed by the fusion of three bones into one massive, irregular bone, the os coxa. The two hip bones are joined together anteriorly in the symphysis pubis. Posteriorly, the hip bones are fused to the sacrum. Each hip bone has three distinctive parts—the ilium, ischium and pubis (fig. 2–13). The ilium is the broad, flaring flat, spade-shaped bone, forms the posterior part of the pelvic girdle. The coccyx is the "tail bone," the thin, curving end of the vertebral column. In the adult, five sacral bones have fused to form one sacrum, and four coccygeal bones have fused to form one coccyx.

2-16. The Thorax

The thorax, or chest cage, is formed by 25 bones: 12 thoracic vertebrae, 2 pairs of ribs, and 1 sternum. Rib cartilages (costal cartilages) complete the chest cage. The thorax contains and protects the heart, lungs, and related structures of circulation and respiration. The ribs curve outward, forward, and downward from their posterior attachments to the vertebrae. The first seven pairs of ribs are joined directly to the sternum by their costal cartilages. The next three pairs (numbered 8, 9, 10), are attached to the sternum indirectly—each cartilage attaches to the one above—while the last two pairs, "the floating ribs," are not attached to the sternum. The sternum is the anterior flat breastbone and the ribs form the expandable chest cage wall.

2-17. The Shoulder Girdle and Upper Limbs

(fig. 2-11)

The shoulder girdle is a flexible yoke that suspends and supports the arms. Held in place by muscles, it has only one point of attachment to the axial skeleton—the joint between the clavicle and sternum. The shoulder girdle is formed by two scapulae posteriorly and two clavicles anteriorly. The bones of the shoulder and upper limb include the scapula (shoulder blade); clavicle (collar bone); humerus (arm bone); radius and ulna (forearm bones); carpals (wristbones); metacarpals (hand bones); and phalanges (finger bones).

a. The scapula is a large triangular bone extending from the second to the seventh or eighth ribs, posteriorly. The heavy ridge extending across the upper surface of the scapula ends in a process called the acromion, which forms the tip of the shoulder and the joint with the clavicle, anteriorly. A socket for the head of the humerus is on the lateral surface of the scapula. Strong muscles attach to the scapula for shoulder and arm movement.

b. The clavicle is a slender, S-curved bone lying horizontally above the first rib. The lateral end of the clavicle forms a joint with the scapula (acromio-clavicular joint). The medial end of the clavicle forms a joint with the sternum at the sterno-clavicular joint, which can be felt as the knob on either side of the notch at the base of the throat. The clavicle acts as a shoulder brace, holding the shoulder up and back. When the clavicle is fractured, the shoulder slumps forward.

c. The humerus is a heavy long bone in the arm that extends from the shoulder to the elbow. The rounded proximal end fits into the scapula in a socket, the glenoid fossa. The distal end of the humerus forms the elbow joint, articulating with the ulna and part of the radius. Strong muscles reinforce the shoulder joint and attach to the humerus, protecting the large blood vessels and nerves that extend along the bone.

d. The radius and ulna (fig. 2-12) are the bones of the forearm. The ulna, on the little finger side, forms the major part of the elbow joint with the humerus. A projection of the ulna, the olecranon, is the "funny bone" at the point of the elbow. The radius, on the thumb side, forms the major part of the wrist joint. The action of the radius about the ulna permits hand turning.

e. The wrist (fig. 2-12) has eight small bones (carpal bones) arranged in two rows of four each. They articulate with each other and with the bones of the hand and forearm. Articulating with the carpals are five metacarpals which form the bony structure of the palm of the hand. The metacarpal of the thumb is particularly important—its muscular attachment permits the thumb to meet the other fingers of the hand, an action called opposing. (This opposing thumb enables the human hand to manipulate articles with great dexterity.) The 14 phalanges in each hand are the finger bones, 3 in each finger and 2 in each thumb. The nerves, blood vessels, and tendons in the hand and wrist are close to the surface and, when injured, can cause serious disability. Injuries to the hand require special evaluation and painstaking treatment to prevent deformities and crippling of finger movements.

2-18. The Pelvis and Lower Limbs

The two hip bones form the pelvic girdle, which provides articulation for the lower limbs. The pelvis, jointed by the hip bones, sacrum, and coccyx, forms a strong bony basin which supports the trunk and protects the contents of the abdomino pelvic cavity. When the upright body is in proper alinement, the pelvis distributes the weight evenly to both lower extremities. The bones of the pelvis

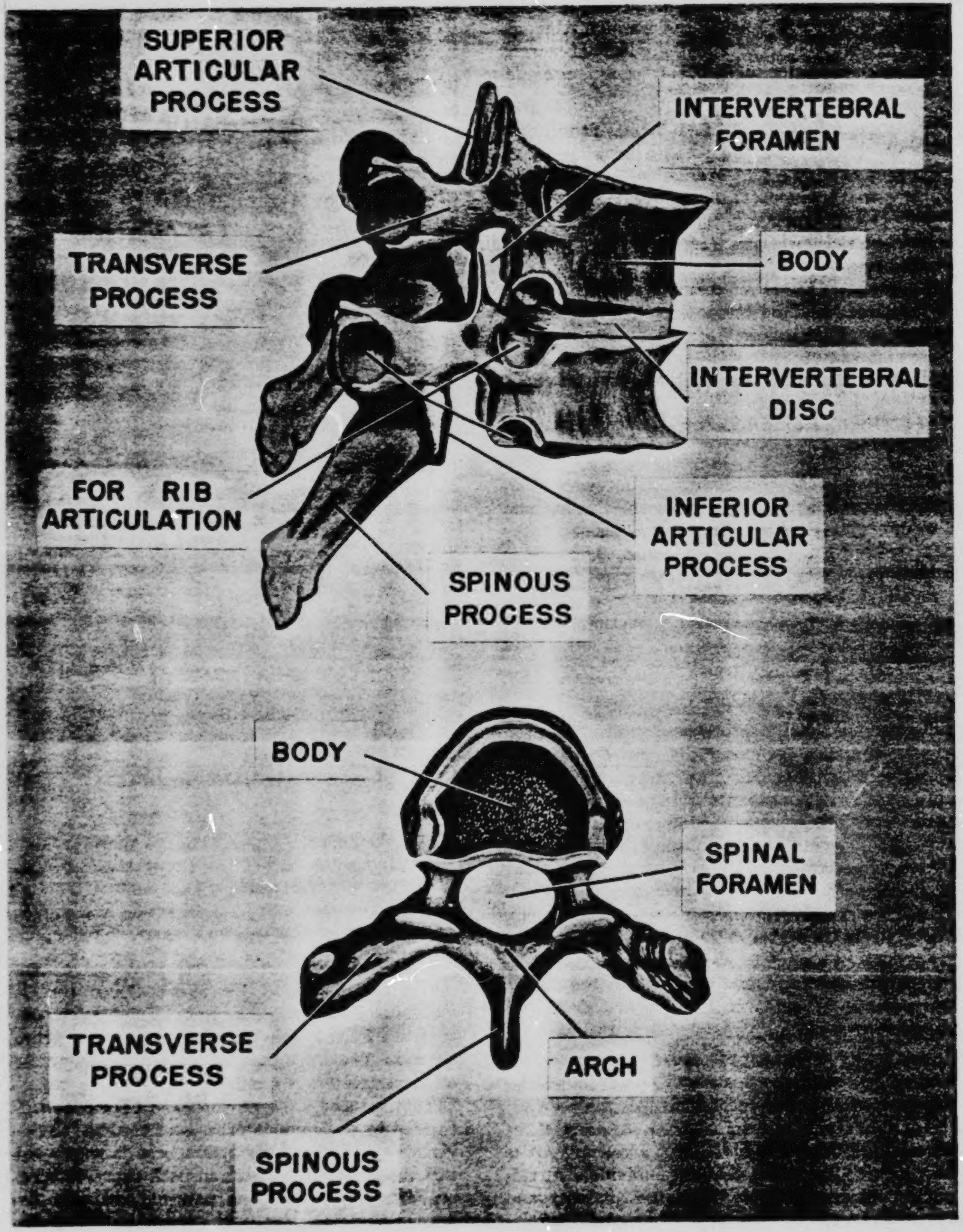

SUPERIOR ARTICULAR PROCESS
INTERVERTEBRAL FORAMEN
TRANSVERSE PROCESS
BODY
INTERVERTEBRAL DISC
FOR RIB ARTICULATION
INFERIOR ARTICULAR PROCESS
SPINOUS PROCESS
BODY
SPINAL FORAMEN
TRANSVERSE PROCESS
ARCH
SPINOUS PROCESS

Figure 2-10. Typical vertebrae.

inner parts of the ear. The ethmoid and sphenoid bones complete the floor of the cranium, the ethmoid toward the front and the sphenoid toward the center. The air spaces in the frontal, ethmoid, and sphenoid bones are sinuses.

b. Facial Bones. The 14 facial bones fit together like a very complicated jigsaw puzzle; for example, part of 7 different cranial and facial bones form each eye socket; 2 maxillary bones, the upper jaw; 2 zygomatic, the upper cheeks; and 1 mandible, the lower jaw (fig. 2-8 Ⓑ). The maxillary bones support the upper teeth, and the mandible supports the lower teeth. The joints formed by the mandible and temporal bones permit jaw movement. Nine smaller facial bones complete the nose and roof of the mouth (two nasal, two turbinate, one vomer, two lacrimal, and two maxilla).

2-15. The Vertebral Column

(fig. 2-9)

The 26 bones of the vertebral column form a flexible structure, supporting the head, thorax, and the upper extremities. The arrangement of the vertebrae provides a protected passageway for the spinal cord. Vertebral bones are classified into four regions—cervical (neck); thoracic (chest); lumbar (lower back); and sacral-coccygeal (pelvic).

a. Vertebral Structure.

(1) A typical vertebra has an anterior portion, the body, and a posterior portion, the arch (fig. 2-10). The body and the arch encircle the spinal canal, the opening through which the spinal cord passes. Between vertebral bodies are the intervertebral discs, which are fibrocartilage structures that serve as shock-absorbing connections between vertebrae. The irregular projections from the arches are spinous processes posteriorly (these are the projections you feel when you run your fingers along the midline of the back) and transverse processes laterally. Intervertebral foramena are openings on either side of the arches for passage of spinal nerves to and from the spinal cord.

(2) The movement of casualties suspected of having a spinal injury is always potentially hazardous. Careless movement increases the possibility of damage to the spinal cord. At least three persons are needed to move such a casualty. It is particularly important that the individual directing the movement understand the anatomy and physiology of the vertebral column and its relationship with the spinal cord and nerves.

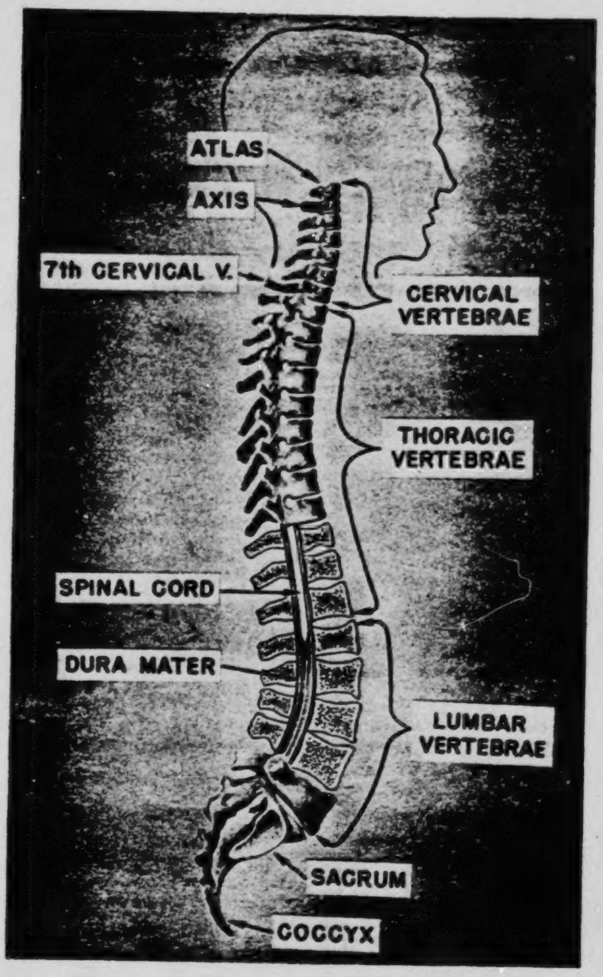
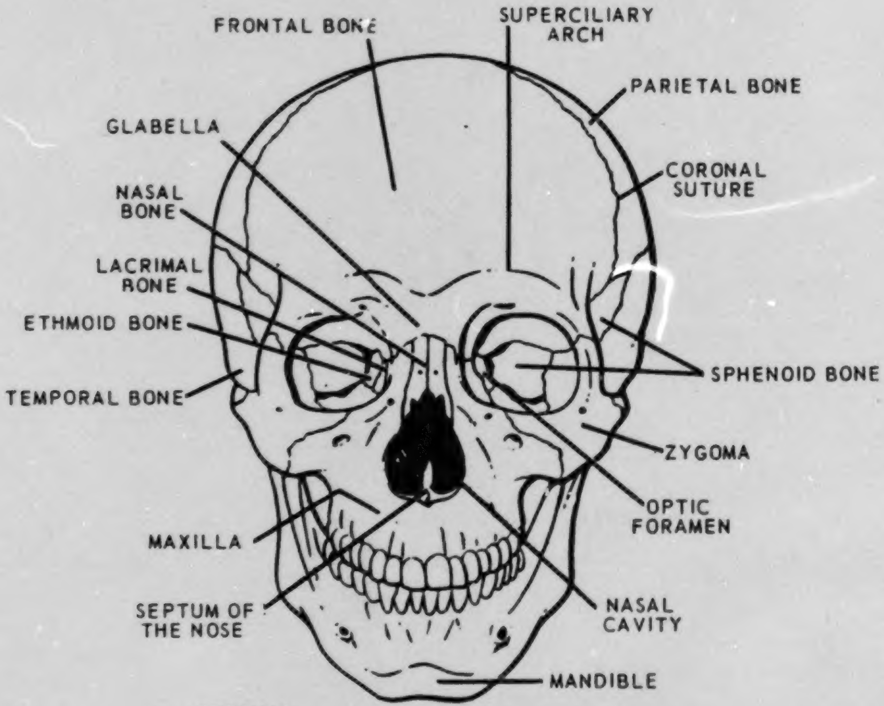


Figure 2-9. Vertebral column.

b. Vertebral Curves. The vertebral column has four normal curves for strength and balance—cervical and lumbar curves are concave, curving inward; thoracic and sacral curves are convex, curving outward. Abnormal, exaggerated spinal curvatures can be disabling.

c. Classification of Vertebrae. Seven cervical vertebrae are in the neck region. The first cervical vertebra is called the atlas, the second vertebra, the axis. These are the only named vertebrae. All other vertebrae are numbered according to region. The prominent knob at the base of the neck is formed by the spinous process of the 7th cervical vertebra. Twelve thoracic vertebrae form the posterior wall of the chest, and each thoracic vertebra articulates with one pair of ribs. The five lumbar vertebrae are in the lower back and support the posterior abdominal wall. The sacrum, a


FRONTAL BONE
SUPERCILIARY ARCH
PARIETAL BONE
GLABELLA
CORONAL SUTURE
NASAL BONE
LACRIMAL BONE
ETHMOID BONE
SPHENOID BONE
TEMPORAL BONE
ZYGOMA
OPTIC FORAMEN
MAXILLA
SEPTUM OF THE NOSE
NASAL CAVITY
MANDIBLE

FRONTAL VIEW

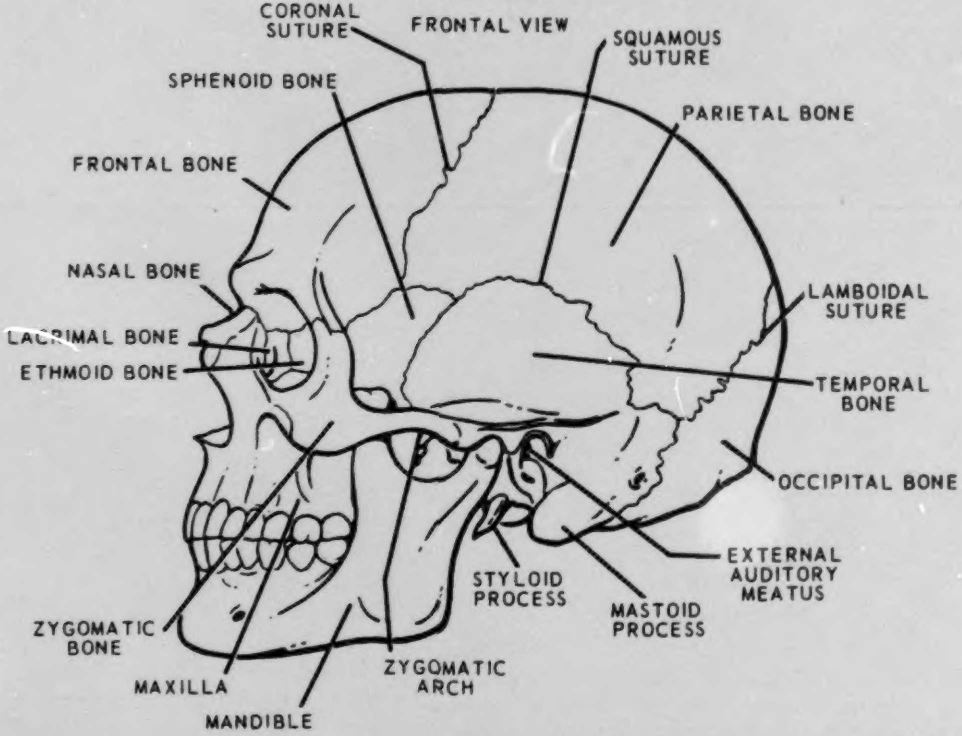

CORONAL SUTURE
SQUAMOUS SUTURE
SPHENOID BONE
PARIETAL BONE
FRONTAL BONE
NASAL BONE
LAMBOIDAL SUTURE
LACRIMAL BONE
ETHMOID BONE
TEMPORAL BONE
OCCIPITAL BONE
EXTERNAL AUDITORY MEATUS
STYLOID PROCESS
MASTOID PROCESS
ZYGOMATIC BONE
MAXILLA
ZYGOMATIC ARCH
MANDIBLE

Figure 2-8. The skull.

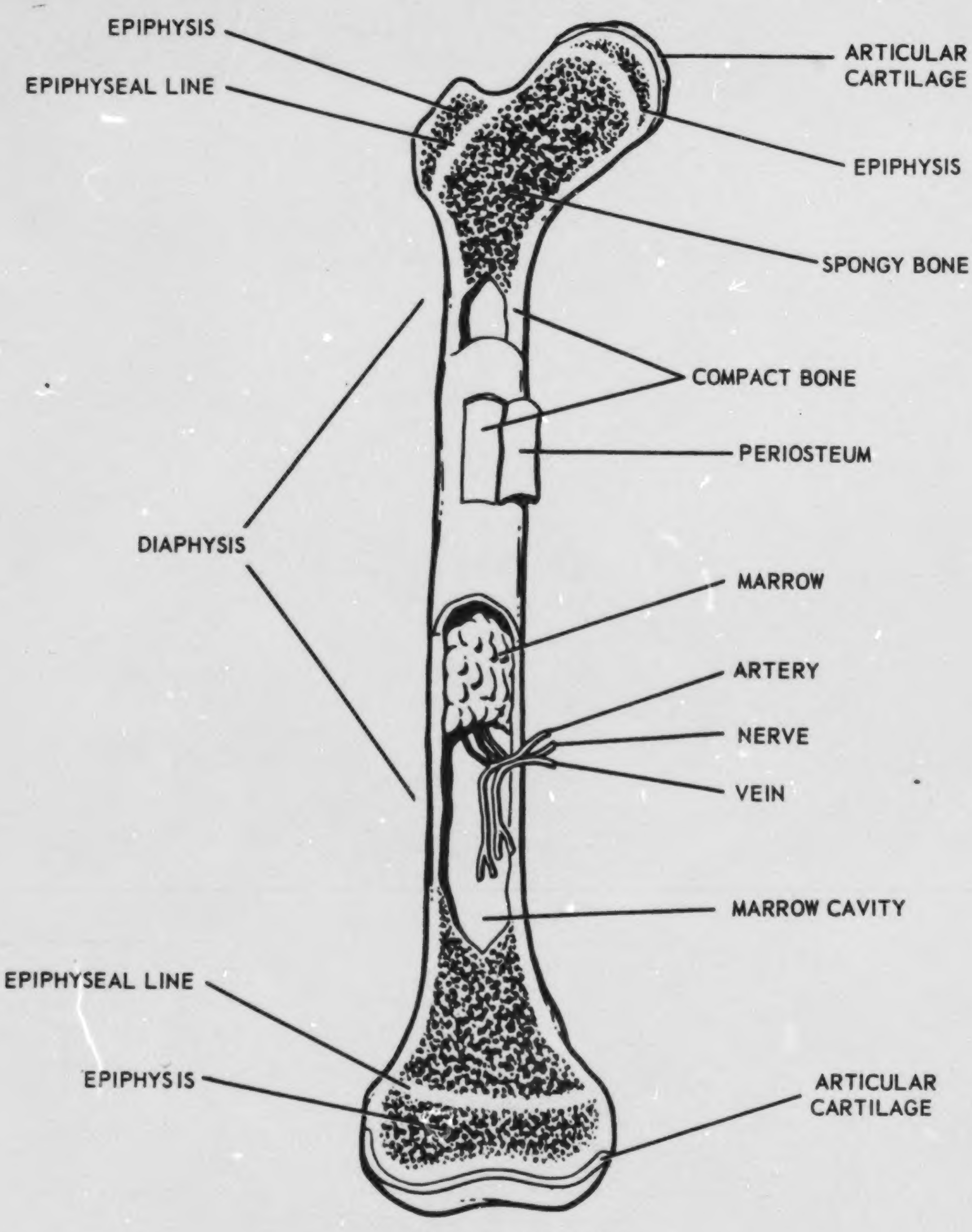

EPIPHYSIS
EPIPHYSEAL LINE
ARTICULAR CARTILAGE
EPIPHYSIS
SPONGY BONE
COMPACT BONE
PERIOSTEUM
DIAPHYSIS
MARROW
ARTERY
NERVE
VEIN
MARROW CAVITY
EPIPHYSEAL LINE
EPIPHYSIS
ARTICULAR CARTILAGE

Figure 2-7. A long bone (femur).

cranial bones include one frontal, two parietal, one occipital, two temporal, one ethmoid, and one sphenoid (fig. 2-8 Ⓐ). The frontal bone forms the forehead, part of the eye socket, and part of the nose. The parietal bones form the dome of the skull and the upper side walls. The occipital bone forms the back and base of the skull. (The foramen magnum, the large hole in the lower part of the occipital bone, is the passageway for the spinal cord.) The temporal bones form the lower part of each side of the skull and contain the essential organs of hearing and of balance in the middle and *b. Divisions of the Skeleton.* For study purposes, the 206 bones of the adult are divided into the bones of the axial skeleton (80 bones) and the appendicular skeleton (126 bones). The axial skeleton includes the skull, vertebral column, ribs, and sternum. The appendicular skeleton includes bones of the shoulder girdle, upper limb, the pelvic girdle, and lower limb.

2–11. Bone Structure and Shape of Bones

a. Bone is living tissue, containing blood vessels and nerves within the hard bone structures. The living cells that form bones are osteocytes. Bone cells have the ability to select calcium and other minerals from blood and tissue fluid and to deposit the calcium in the connective tissue fibers between cells. With increasing age, from childhood to adulthood, bones become harder; in old age, bones become brittle because there are higher proportions of minerals and fewer active cells. Periosteum, the membrane covering bone surfaces, carries blood vessels and nerves to the bone cells. Bone-producing cells in periosteum are active during growth and repair of injuries. Two kinds of bone are formed by the bone cells—compact and cancellous. Compact bone is hard and dense, while cancellous bone has a porous structure. The combination of compact and cancellous bone cells produces maximum strength with minimum weight.

b. Bones are classified by their shape as long, short, flat, and irregular. Long bones are in the extremities and act as levers to produce motion when acted on by muscles. Short bones, strong and compact, are in the wrist and ankle. Flat bones form protective plates and provide broad surfaces for muscle attachments; *for example,* the shoulder blades. Irregular bones have many surfaces and fit into many locations; *for example,* the facial bones, vertebral, and pelvic bones. A long bone is used as an example of bone structure (fig. 2–7).

(1) Long bones have a shaft (the diaphysis) and two extremities (the epiphyses). The shaft is a heavy cylinder of compact bone with a central medullary (marrow) cavity. This cavity contains bone marrow, blood vessels, and nerves. Cancellous bone is located toward the epiphyses and is covered by a protecting layer of compact bone.

(2) Articular cartilage covers the joint surfaces at the ends of a long bone. The cartilage provides a smooth contact surface in joint formation and gives some resilience for shock absorption.

(3) Periosteum, the membrane covering the bone surface, is anchored to the bone by connective tissue fibers. It is essential for bone nourishment and repair. In severe bone injuries, the periosteum may be torn away or damaged, inhibiting repair of the bone.

2–12. Bone Marrow

Two kinds of marrow, yellow and red, are found in the marrow cavities of bones. Red bone marrow is active blood cell manufacturing material, producing red blood cells and many of the white blood cells. Deposits of red bone marrow in an adult are in cancellous portions of some bones—the skull, ribs, and sternum, for example. Yellow bone marrow is mostly fat and is found in marrow cavities of mature long bones. The examination of red marrow deposits is important for diagnostic tests when the condition of developing blood cells must be determined. For microscopic examination, the doctor obtains a small amount through a special needle puncture, usually in the sternum.

2–13. Bone Landmarks

The special markings and projections on bones are used as points of reference. Each marking has a function; *for example,* in joint formation, for muscle attachments, or as passageways for blood vessels and nerves. Terms used to refer to bone markings include—

a. Foramen—an opening, a hole.

b. Sinus—an air space.

c. Head—a rounded ball end.

d. Neck—a constricted portion.

e. Condyle—a projection fitting into a joint.

f. Fossa—a socket.

g. Crest—a ridge.

h. Spine—a sharp projection.

2–14. The Skull

The skull forms the framework of the head. It has 29 bones—8 cranial, 14 facial, 6 ossicles (3 tiny bones in each ear), and 1 hyoid (a single bone between the skull and neck area).

a. Cranial Bones. The cranial bones support and protect the brain. They fuse together after birth in firmly united joints called sutures. The eight

Section III. THE SKELETAL SYSTEM

2-10. Functions and Divisions
(fig. 2-6 Ⓐ and Ⓑ)

The skeletal system includes the bones and the joints (articulations), where separate bones come together. The skeletal system has several important functions, in addition to providing the bony framework of the body.

a. Skeletal System Function.

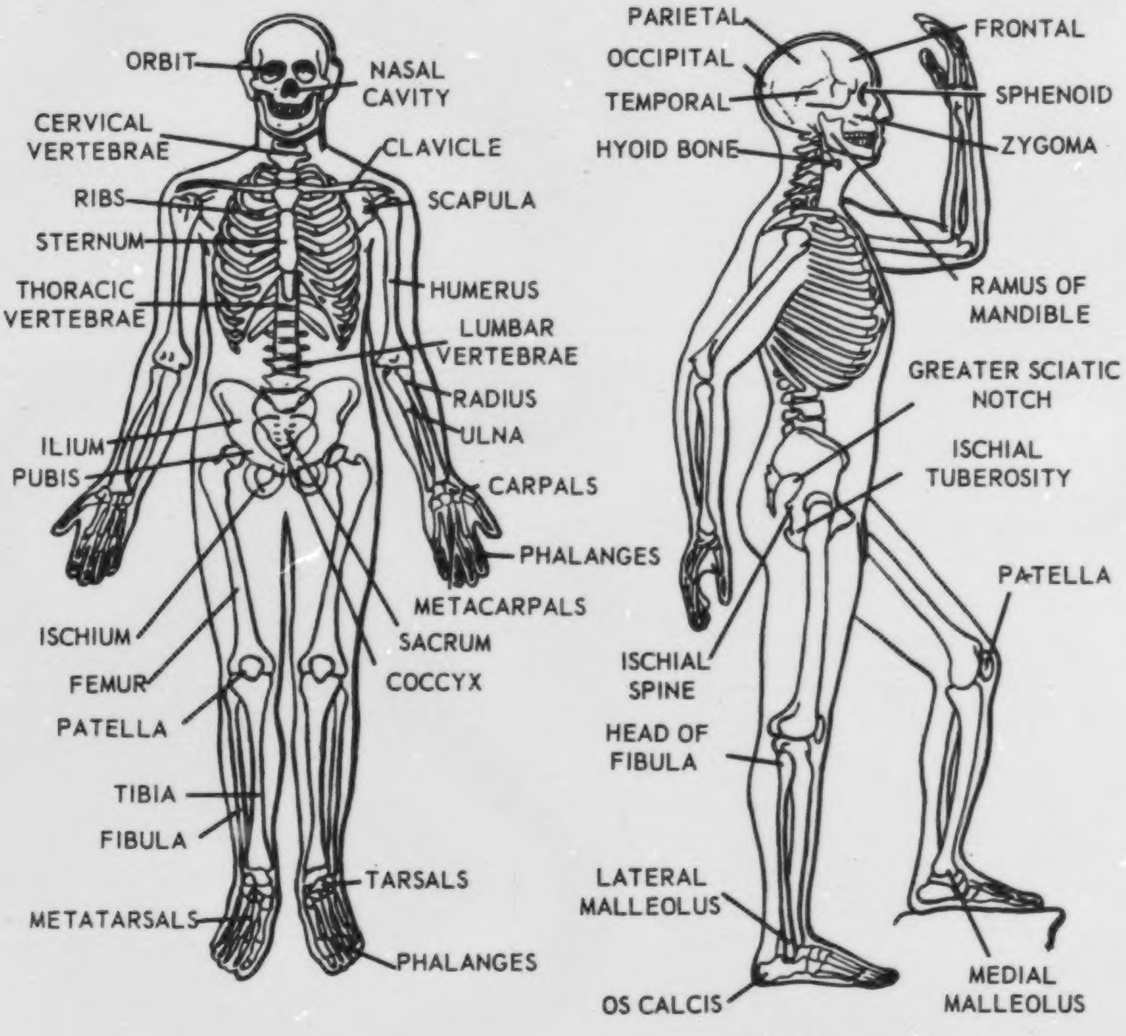
(1) To give support and shape the body.

(2) To protect internal organs.

(3) To provide movement when acted upon by muscles.

(4) To manufacture blood cells.

(5) To store mineral salts.


ORBIT
NASAL CAVITY
CERVICAL VERTEBRAE
CLAVICLE
RIBS
SCAPULA
STERNUM
THORACIC VERTEBRAE
HUMERUS
LUMBAR VERTEBRAE
RADIUS
ULNA
ILIUM
PUBIS
CARPALS
PHALANGES
METACARPALS
ISCHIUM
SACRUM
FEMUR
COCCYX
PATELLA
TIBIA
FIBULA
TARSALS
METATARSALS
PHALANGES
PARIETAL
FRONTAL
OCCIPITAL
TEMPORAL
SPHENOID
HYOID BONE
ZYGOMA
RAMUS OF MANDIBLE
GREATER SCIATIC NOTCH
ISCHIAL TUBEROSITY
PATELLA
ISCHIAL SPINE
HEAD OF FIBULA
LATERAL MALLEOLUS
MEDIAL MALLEOLUS
OS CALCIS

Ⓐ ANTERIOR VIEW

Ⓑ LATERAL VIEW

NOTE: THE ANATOMICAL POSITION IS ILLUSTRATED IN Ⓐ

Figure 2-6. Human skeleton.

consists of the prefix "myo," the stem "card," and the suffix "itis." Myo means "muscle." Card means "cardiac" or "heart." Itis means "inflammation." Thus, myocarditis means inflammation of muscles of the heart. Table 2-1 gives combining forms that are commonly used in medical terminology. These must be learned to understand medical references that will occur from now on.

Table 2-1. Medical Terminology

STEM WORDS	MEANING
adeno	gland
arthro	joint
cardio	heart
cephalo	head
cysto	bladder
cyto	cell
dermo	skin
entero	intestine
gastro	stomach
hemo	blood
hepato	liver
myelo	*spinal cord
myo	muscle
nephro	kidney
neuro	nerve
oculo	eye
osteo	bone
oto	ear
procto	rectum
thoraco	chest
	*or bone marrow

PREFIX	MEANING	EXAMPLE OF USE IN MEDICINE	DEFINITION OF EXAMPLE
a-, an-	absence of, deficiency	atrophy	shrinking, wasting away
endo-	inner, inside	endocardial	inside the heart
epi-	upon, on the outside	epidermis	outside layer of skin
hyper-	more than normal, over	hypertrophy	enlargement
hypo-	less than normal, under	hypotension	low blood pressure
inter-	between	interneural	between nerves
intra-	inside	intraocular	inside the eye
peri-	surrounding	periosteum	membrane surrounding bone

SUFFIX	MEANING	EXAMPLE OF USE IN MEDICINE	DEFINITION OF EXAMPLE
-algia	pain	otalgia	ear ache
-ectomy	surgical removal	nephrectomy	surgical removal of a kidney
-emia	a condition of the blood	septicemia	blood poisoning
-itis	inflammation	hepatitis	inflammation of the liver
-oma	a tumor, a swelling	adenoma	a glandular tissue tumor
-plasty	surgical repair	thoracoplasty	surgical repair of the chest wall
-scopy	looking into or through an instrument	cystoscopy	examination of the urinary bladder through, a cystoscope
-stomy	surgical opening creating a hole	gastrostomy	artificial opening into the stomach through the abdomen
-tomy	surgical incision	arthrotomy	incision into a joint

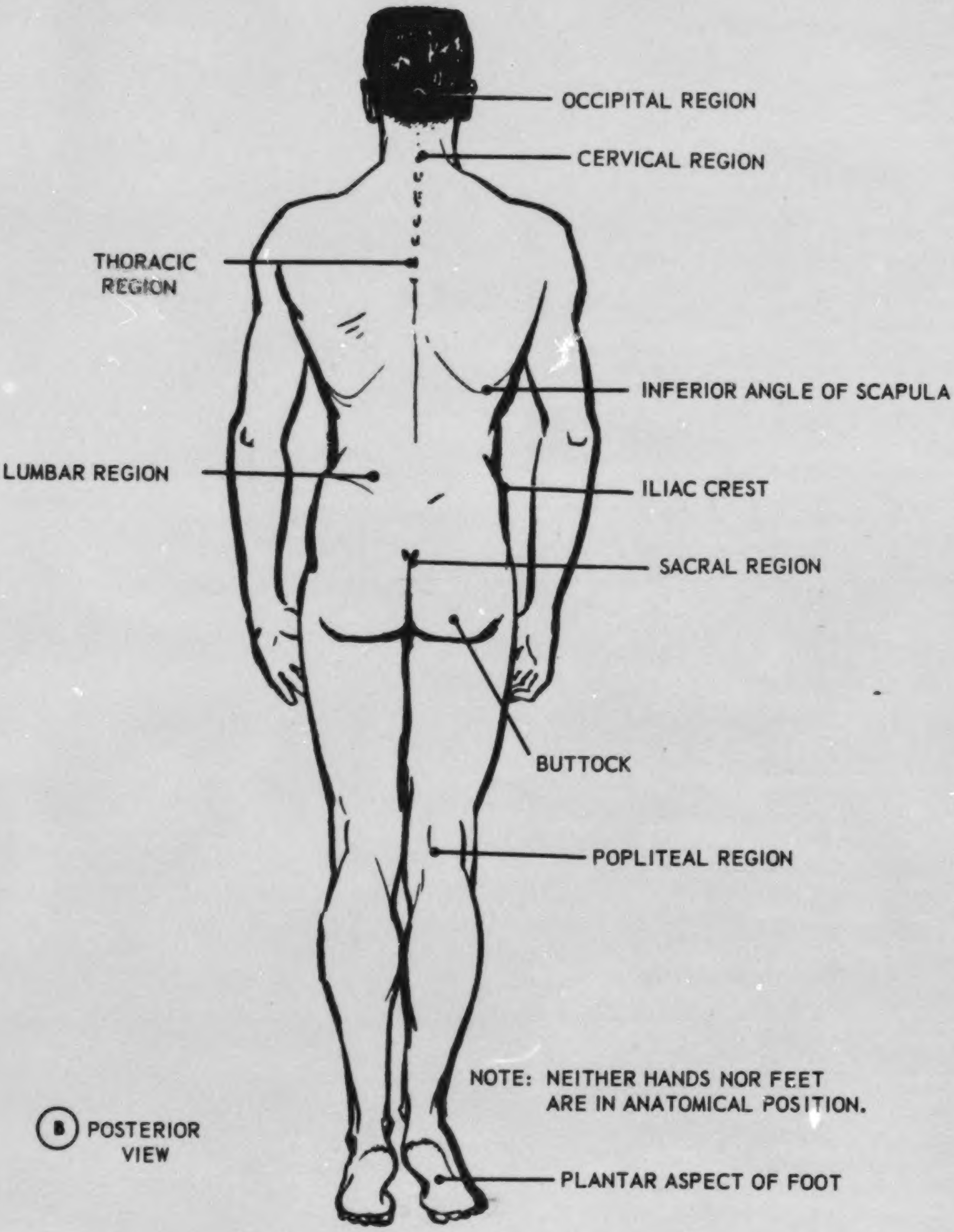

OCCIPITAL REGION
CERVICAL REGION
THORACIC REGION
INFERIOR ANGLE OF SCAPULA
LUMBAR REGION
ILIAC CREST
SACRAL REGION
BUTTOCK
POPLITEAL REGION
NOTE: NEITHER HANDS NOR FEET ARE IN ANATOMICAL POSITION.
B POSTERIOR VIEW
PLANTAR ASPECT OF FOOT

Figure 2-5—Continued.

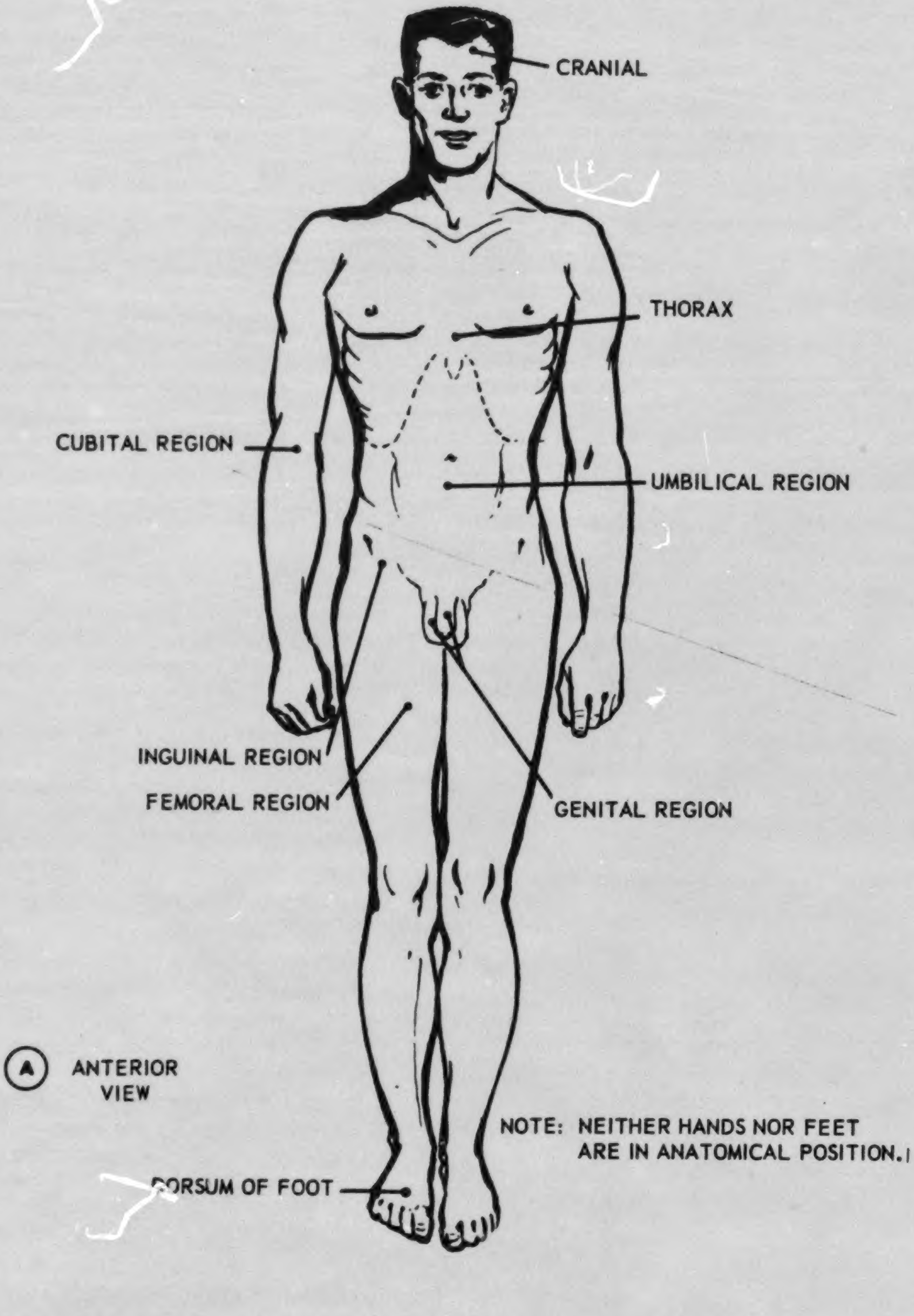

CRANIAL
THORAX
CUBITAL REGION
UMBILICAL REGION
INGUINAL REGION
FEMORAL REGION
GENITAL REGION
A ANTERIOR VIEW
NOTE: NEITHER HANDS NOR FEET ARE IN ANATOMICAL POSITION.
DORSUM OF FOOT

Figure 2–5. Names of body regions.

tion to perform and all of which are interdependent. The body systems and their overall functions are—

a. Skeletal. This system provides the body framework, supports and protects body organs, and furnishes a place of attachment for muscles.

b. Muscular. This system moves and propels the body.

c. Skin. The integumentary system, or skin, covers and protects the entire body surface from injury and infection, has functions of sensation (heat, cold, touch, and pain) and assists in regulation of body temperature and excretion of wastes.

d. Circulatory. This system transports oxygen and nutrient material in the blood to all parts of the body and carries away the waste products formed by the cells.

e. Respiratory. This system takes in air, delivers oxygen from the air to the blood, and removes the waste (carbon dioxide) from the blood.

f. Digestive. This system receives, digests, and absorbs food substances and eliminates waste products.

g. Urinary. This system filters waste products from blood and excretes waste products in urine.

h. Nervous. This system gives the body awareness of its environment, enables it to react to stimuli from the environment, and makes the body work together as a unit.

i. Endocrine. This system controls many body activities by the manufacture of hormones which are secreted into the blood.

j. Reproductive. This system produces and transports reproductive (sex) cells.

Section II. ANATOMICAL AND MEDICAL TERMINOLOGY

2-8. Anatomical Terminology

Terms of position, direction, and location that are used in reference to the body and its parts include the following:

a. Terms of Position.

(1) Anatomical position—the body standing erect, arms at side, palms of hands facing forward. The anatomical position is the position of reference when terms of direction and location are used.

(2) Supine position—the body lying face up.

(3) Prone position—the body lying face down.

(4) Lateral recumbent—the body lying on the left or right side.

b. Terms of Direction and Location.

(1) Superior—toward the head (cranial).

(2) Inferior—toward the feet (caudal).

(3) Anterior—toward the front (ventral—the belly side).

(4) Posterior—toward the back (dorsal—the backbone side).

(5) Medial—toward the midline.

(6) Lateral—to right or left of midline.

(7) Proximal—near point of reference.

(8) Distal—far away from point of reference.

c. Body Regions. Terms of location in relation to body regions are shown in figure 2-5 Ⓐ and Ⓑ.

d. Anatomical Planes. Imaginary straight line divisions of the body are called planes. Medical illustrations and diagrams that indicate internal body structure relationships are labeled to indicate the plane division as—

(1) Sagittal—a lengthwise division, producing right and left sections.

(2) Transverse—a crosswise division, producing top and bottom sections.

(3) Frontal—a side-to-side division, producing front and back sections.

2-9. Medical Terminology

To understand most medical words, all that is necessary is to break the words into their parts and to know the meaning of these parts. Many medical words contain a stem or root to which is affixed either a prefix, a suffix, or both. A prefix is a group of letters combined with the beginning of a word to modify its meaning. A suffix is a group of letters added to the end of a word to modify its meaning. *For example,* the word "myocarditis"

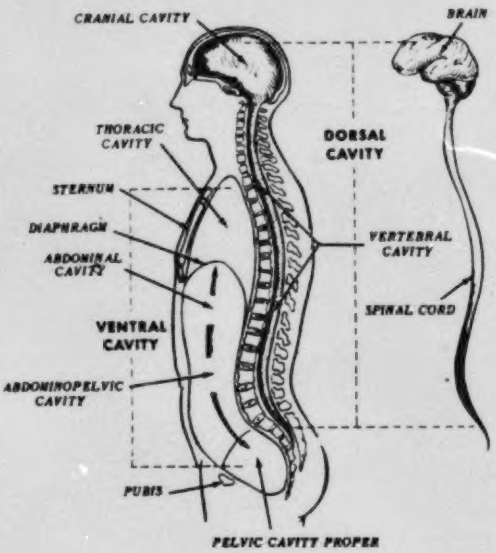

CRANIAL CAVITY
BRAIN
THORACIC CAVITY
DORSAL CAVITY
STERNUM
DIAPHRAGM
ABDOMINAL CAVITY
VERTEBRAL CAVITY
SPINAL CORD
VENTRAL CAVITY
ABDOMINOPELVIC CAVITY
PUBIS
PELVIC CAVITY PROPER

Figure 2-3. Main body cavities.

composed of many organs, each with its own specialized function.

2-5. Body Cavities

The organs of the body are located in certain cavities, the major ones of which are the dorsal cavity (toward the back part of the body) and the ventral cavity (toward the front part of the body) (fig. 2-3).

a. Dorsal Cavity. The dorsal cavity has a cranial area, which contains the brain, and a vertebral area, which contains the spinal cord. These areas are continuous.

b. Ventral Cavity. The ventral cavity has a thoracic cavity and an abdomino pelvic cavity. These areas are separated by the diaphragm.

(1) In the thoracic cavity are two pleural cavities, each containing a lung. In the space between the pleural cavities is the pericardial cavity, which contains the heart, and the mediastinal region, in which are contained the trachea, esophagus, thymus gland, large blood and lymphatic vessels, lymph nodes, and nerves.

(2) In the upper part of the abdomino pelvic cavity are the stomach, small intestine, liver, gallbladder, pancreas, spleen, kidneys, adrenal glands, and ureters. The lower part of the cavity (pelvic cavity) contains the urinary bladder, the end of the large intestine (rectum), and parts of the reproductive system.

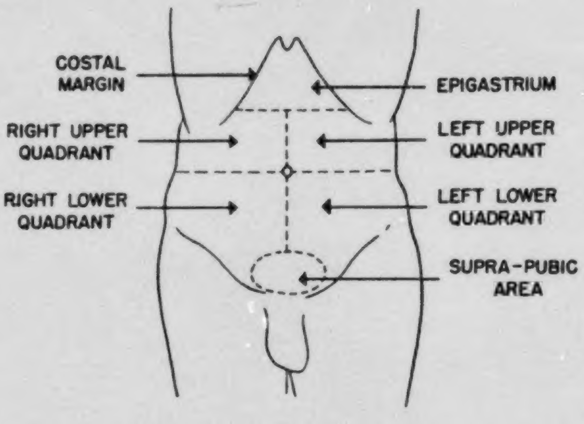

COSTAL MARGIN
EPIGASTRIUM
RIGHT UPPER QUADRANT
LEFT UPPER QUADRANT
RIGHT LOWER QUADRANT
LEFT LOWER QUADRANT
SUPRA-PUBIC AREA

Figure 2-4. Areas of the abdomen.

c. Anterior Abdominal Surface Area. The large anterior area of the abdomino pelvic cavity is divided into four parts or quadrants (fig. 2-4). Initials that identify quadrants are LUQ (left upper), RUQ (right upper), LLQ (left lower), and RLQ (right lower). These initials are often used to indicate the approximate location of an organ, pain, a wound, or a surgical incision. In addition to identification by quadrants, the upper central abdominal region is referred to as epigastric (over the stomach), and the lower central region as suprapubic (above the pubis). The rib area is called costal.

2-6. Membranes

Certain membranes are combined layers of tissue that form partitions, linings, envelopes, or capsules. They reinforce and support body organs and cavities. Others are a combination of connective tissues only (*examples:* mucous, pleural, pericardial, and peritoneal membranes). Connective tissue membranes are combinations of connective tissue only (*examples:* meninges, fascia, periosteum, and synovia). Different kinds of membranes are associated with different body systems (*examples:* pleural membranes with the respiratory system; pericardial membranes with the circulatory system; peritoneal membranes with the digestive system; meningeal membranes with the nervous system; fascial membranes with the muscular system; and periosteal and synovial membranes with the skeletal system).

2-7. Body Systems

The organs of the human body are arranged into major systems, each of which has its specific func-

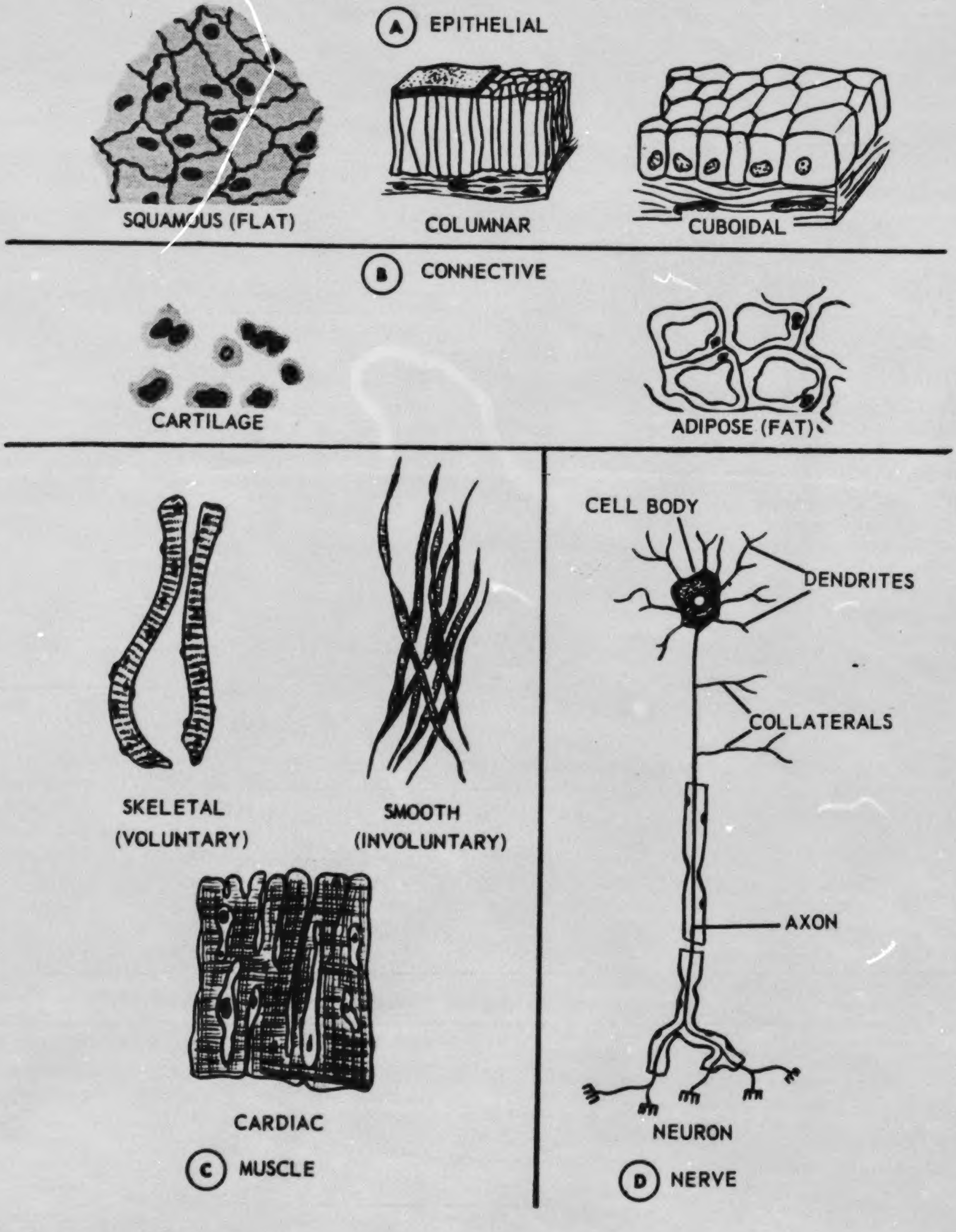

A EPITHELIAL
SQUAMOUS (FLAT)
COLUMNAR
CUBOIDAL
B CONNECTIVE
CARTILAGE
ADIPOSE (FAT)
SKELETAL (VOLUNTARY)
SMOOTH (INVOLUNTARY)
CARDIAC
C MUSCLE
CELL BODY
DENDRITES
COLLATERALS
AXON
NEURON
D NERVE

Figure 2-2. Types of tissues.

(2) *Tissue fluid* is the body fluid that lies outside blood vessels and outside cells and is therefore also called *extravascular* (outside blood vessels) or *extracellular* (outside cells) fluid. Living body cells contain large amounts of water and must be bathed continuously in a watery solution in order to survive and carry on their functions. The colorless and slightly salty tissue fluid is derived from the circulating blood.

2–3. Tissues

A tissue is a part of the body made up of similarly specialized cells which work together to perform particular body functions. There are four main types of tissues, each of which has a particular function (fig. 2–2).

a. Epithelial. Epithelial tissue forms the outer layer of skin for the protection of the body. It is also a lining tissue. As *mucous membrane*, it lines the nasal cavity, mouth, larynx, pharynx, trachea, stomach, and intestines. As *serous membrane*, it lines the abdominal, chest, and heart cavities and covers the organs that lie in these cavities. As *endothelium*, it lines the heart and blood vessels. It lines respiratory and digestive organs for the functions of protection and absorption. It helps form organs concerned with the excretion of body wastes, certain glands for the purpose of secretion, and certain sensory organs for the reception of stimuli. Based on the shape of the cells, there are 3 types of epithelial tissue (fig. 2–2Ⓐ). As illustrated, squamous (flat) epithelial cells in a single layer compose such structures as the microscopic air sacs of the lungs; in other places as in the skin, squamous epithelium is in several layers or stratified (not illustrated). Columnar epithelium cells are more important in the formation of ducts.

b. Connective. Connective tissue is distributed throughout the body to form the supporting framework of the body and to bind together and support other tissues. It binds organs to other organs, muscles to bones, and bones to other bones. There are five principal types of connective tissue—

(1) Areolar tissue is a fibrous connective tissue which forms the subcutaneous layer of tissue. It fills many of the small spaces on the body, and it helps to hold organs in place.

(2) Adipose tissue (fig. 2–2Ⓑ) is a fatty connective tissue which is found under the skin and in many other regions of the body. It serves as a padding around and between organs. It insulates the body, reducing heat loss, and it serves as a food reserve in emergencies.

(3) Reticular tissue is a fibrous connective tissue which forms the supporting framework of lymph glands, liver, spleen, bone marrow, and lungs.

(4) Elastic tissue is a fibrous connective tissue composed of elastic fibers and is found in the walls of blood vessels, in the lungs, and in certain ligaments.

(5) Cartilage (fig. 2–2Ⓑ) is a tough, resilient connective tissue found at the ends of the bones, between bones, and in the nose, throat, and ears.

c. Muscular. Muscular tissue is composed of long, slender cells held together by connective tissue. There are three kinds of muscle tissues: striated, smooth, and cardiac (heart muscle). Muscle tissue has the ability to contract (shorten) and, by so doing, to produce movement.

(1) Striated muscle has striations (its fibers are divided by transverse bands) (fig. 2–2Ⓒ) when viewed through a microscope. Because most striated muscle attaches to bones, it is often referred to as skeletal muscle. Skeletal muscle contraction is stimulated by impulses from nerves and, in theory, the nerve impulses can be controlled by voluntary or conscious effort. Skeletal muscle tissue is therefore referred to as striated, voluntary muscle tissue.

(2) Smooth muscle which has no striations when viewed through a microscope (fig. 2–2 Ⓒ), is found in the walls of internal organs (viscera), blood vessels, and internal passages. Contraction of smooth muscle helps propel the contents of internal structures along. Smooth muscle contractions are stimulated by nerve impulses not under conscious control. Smooth muscle is therefore referred to as visceral, nonstriated, involuntary muscle.

(3) Cardiac muscle (fig. 2–2Ⓒ) is found only in the walls of the heart; i.e., myocardium is heart muscle.

d. Nervous. Nervous tissue is composed of cells highly specialized to receive and transmit impulses (messages). These nerve cells, which are called neurons (fig. 2–2Ⓓ), are bound together by a special structure called neuroglia.

2–4. Organs

An organ is a group of tissues which has combined to perform a specific function. The body is

CHAPTER 2

ANATOMY AND PHYSIOLOGY

Section I. BASIC CONCEPTS

2-1. General

The science of anatomy is the study of the structure of the body, its organs, and the relation of its parts. There are many subdivisions or branches of this science. Physiology is the study of the functions and activities of the parts of the body. This science also has many subdivisions. In this chapter both anatomy and physiology will be presented in the discussion of the structure and function of the various systems of the human body, all of which are closely interrelated and interdependent.

2-2. Cells

The cell is the basic functioning unit in the composition of the human body, as well as in all other living organisms. The human body is composed of billions of cells which vary in shape and size. Cells are microscopic in size, however, the largest being only about 1/1000 of an inch. Because of this, a special unit of measurement, the micron, is used to determine cell dimensions. (One micron equals 1/1000 millimeter or about 1/25,000 of an inch.) A group of the same type of cells is called a tissue and performs a particular function. The human body is composed of many groups of cells performing a variety of functions.

a. Cells reproduce to replace wornout cells, to build new tissues, and to bring about the growth of the body as a whole. Cells reproduce themselves or increase by dividing, maturing, and dividing again. This process is known as growth by division. It results in a mass of apparently identical cells; however, as cell division continues, differences begin to appear in various groups of cells as they develop the characteristics necessary for them to perform their roles in the development and functions of the body. This development of special characteristics is called *cell differentiation.*

b. Cells are composed of a substance called protoplasm. A typical animal cell (fig. 2-1) is made up of a cell membrane and two main parts—the *nucleus* and the *cytoplasm,* which are types of protoplasm. The *nucleus* controls all activities of the cell, including growth and reproduction. *Cytoplasm* is the matter surrounding the nucleus and is responsible for most of the work done by the cell. The cell membrane incloses the protoplasm and permits the passage of fluid into and out of the cell. This permeable cell membrane is an important structural feature of the cell. It is through the cell membrane that all materials essential to metabolism are received and all products of metabolism are disposed of. The bloodstream and tissue fluid which constantly circulate around the cell transports the materials to and from cells.

(1) *Metabolism* is the ability to carry on all the chemical activities required for cell function. It includes using food and oxygen, producing and eliminating wastes, and manufacturing new materials for growth, repair, and use by other cells.

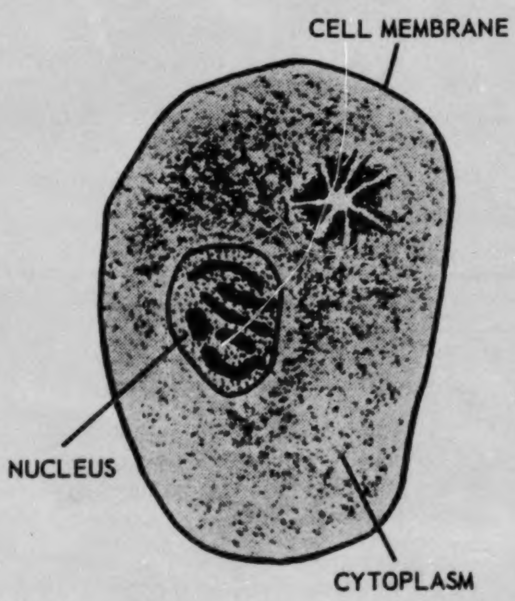


Figure 2-1. Simple cell.

patient to cleanse mouth and teeth thoroughly. Comb hair. Assist male patient to shave. Remove all hair pins, nail polish, and lipstick from female patient.

5. Remove, identify, and store prosthetic appliances, if any, in the bedside table. Place clean dentures in clean water in a labeled denture cup.
6. Dress patient in accordance with the local SOP. This may stipulate that no clothing is worn to the OR or that a clean pajama coat may be permissible, worn back to front, and left unbuttoned.
7. Check to be sure all valuables have been turned in to the Patient's Trust Fund Depository (cash, checks, wristwatch, and other jewelry). If the patient wishes to wear a wedding ring, secure it by a loop of gauze bandage tied to the wrist.
8. Have patient void before giving preoperative medication. Measure and record amount of urine on Nursing Notes.
9. Give prescribed medication as ordered. Caution patient not to attempt to get out of bed after receiving it. Use bedrails if necessary.
10. Do not allow the patient to smoke after receiving medication—remove cigarettes and matches from his bedside table if necessary.
11. Escort the OR technician to the preoperative patient. If the patient is alert, identify by asking his name. If heavily sedated or not conscious, check his bed card and wristband.
12. Assist the OR technician in transferring the patient to the stretcher.
13. Check Clinical Record for final notations and all necessary forms. Complete all entries on Nursing Notes, Doctor's Order, and checklist p.r.n.
14. Give Clinical Record including X-ray folder to the OR technician.

Transportation of the Patient to the Operating Room

The patient is usually transferred to the OR by OR personnel. However, if this is a responsibility of ward personnel, the following precautions must be observed:

1. Cover the patient with a clean cotton sheet and a clean cotton blanket. The amount of covering will depend upon the temperature and draftiness of corridors through which he is to be transported.

WARNING

If a woolen blanket must be used, the blanket is removed before entering the OR suite because of the danger of static electricity in an area where anesthetic gases are used.

2. Secure stretcher straps, one at the chest and one just below the knees before leaving the bedside. Do not apply straps tightly. Explain to the patient that they are for safety.

NOTE

If patient is transported in his bed, always have bedrails in up position.

3. When transporting the patient, never leave him alone and unattended. An assistant is often needed to hold open the elevator and corridor doors.
4. Push the stretcher feet first. Do not push it too fast, and keep it under control at all times. Use care in going through doorways and around corners.
5. Upon arrival at the OR remain with the patient just at the door or entrance until met by a responsible OR individual. Check the patient's identity with this individual and turn over the Clinical Record and the patient to his custody.
6. If the patient is awake, introduce him by name to the new individual. This is a source of reassurance to the patient in the new and mystifying atmosphere.
7. Always find out if the stretcher or bed used is to be returned immediately to the ward or left in the anteroom. (When the ward stretcher or the patient's bed is used, the patient is transferred to an OR stretcher or mobile table for movement into the OR suite.)

5–103. Skin Preparation

Skin preparation for surgery ("surgical prep") consists of cleansing and shaving an area of skin sufficiently large to provide an ample clean field for the specified operative procedure. The area to be shaved is ordered by the doctor. The procedure is often done by OR personnel but is also performed by ward personnel. Although it is preferable to bring the patient to a treatment room because of better facilities, the entire procedure can be done at the bedside. It is usually done the day or evening before surgery.

EQUIPMENT

Instrument tray (15 by 9 by 2 inches) with the following prep equipment:

Safety razor

New razor blades
Scissors
Solution basin, 2
Emesis basin
Water
Surgical soap (as prescribed)
Gauze fluffs, 12 or more
Cotton-tipped applicators
Orangewood stick
Nail clippers p.r.n.
Hair clippers p.r.n.
Plastic-backed paper pad or rubber treatment sheet with cover
Waste container (paper or plastic bag)
Floorlamp

AREAS OF SKIN PREPARATION

Areas customarily prepared for specified operations are illustrated in appendix C. (A general rule followed by experienced operating room personnel can be expressed as "when in doubt, prepare an area extending 12 inches in all directions from the proposed incision.") Since the prepared area is always more extensive than required for the incision itself, the patient must always be told this and reassured.

GENERAL PRECAUTIONS

Observe the following precautions when preparing the skin area:

1. Avoid scratching or nicking the skin. Cuts and scratches are a potential source of infection.
2. Check the doctor's order or the local policy manual for the required skin cleansing agent.
3. If a surgical soap such as a hexachlorophene detergent preparation is used, do not use other soap solutions, acetone, ether, or alcohol with it. These chemicals will neutralize the residual antiseptic properties of the prescribed detergent. If a solvent such as ether or acetone is required to remove adhesive marks or nail polish, use the solvent first and then wash it off.
4. Report any signs of pimples, a rash, or an inflammation about the operative area.

PROCEDURE

1. Check doctor's order. Know area to be prepared. When no specific instructions are given, follow the instructions below and refer to appendix C.
2. Identify the patient and explain the procedure to him.
3. Screen the patient to provide privacy. Position him to provide complete exposure of area and place protective pad under area. Adjust the light to the best angle to see hairs.
4. Wash hands.
5. Using solvent and gauze sponges, remove all adhesive marks and any fingernail polish from nails.
6. Cut off excessive hair with scissors.
7. Moisten gauze, add several drops of detergent, and lather one small area at a time, using a rotating motion. Start at the center and work outward.
8. Using cotton-tipped applicators and orangewood stick, clean all identations such as the umbilicus, toe, and fingernails, if included in the operative area.
9. Reapply lather and shave the clean skin. Apply tension by pulling the skin taut, use short strokes, and shave in the direction of hair growth. Remove lather and hair from razor blade with paper tissue. Rinse the shaved area with clear warm water, using clean fluffs. Blot dry.
10. Inspect the shaved area by viewing in good light at eye level. Reshave where needed.
11. Instruct patient to take a shower and shampoo after shaving is completed if he is physically able. Give him the same detergent used for the skin prep. Provide him with clean towel and clean pajamas. (His bed should be made with clean linen.)
12. Discard soiled sponges, applicators, and used razor blades.
13. Rinse and return basins, razor, scissors, and clippers to CMS for autoclaving.
14. Reassemble clean skin prep tray.

5-104. Orthopedic Skin Preparation

In most Army Medical Department hospitals, the orthopedic skin preparation is done the day before the scheduled date of operation by an orthopedic specialist. The patient is often sent or transported to the orthopedic cast room for the procedure. In general, the orthopedic skin preparation includes shaving as in the routine procedure, followed by a 5-minute scrub of the entire area. When the prepared area is to be draped, as well as shaved and scrubbed, the entire prepared area is covered with sterile towels secured with an elastic bandage or stockinet. (Adhesive tape to secure the towels to the skin is not recommended.) Nursing personnel on the ward must be informed about activity restrictions for the patient on his return to his ward from the preparation area; for example, following preparation of lower extremity, back, and neck, patients remain in bed until time of operation; or following preparation of shoulder, arm, and hand, patients may be up and about but must remain on the ward.

NOTE

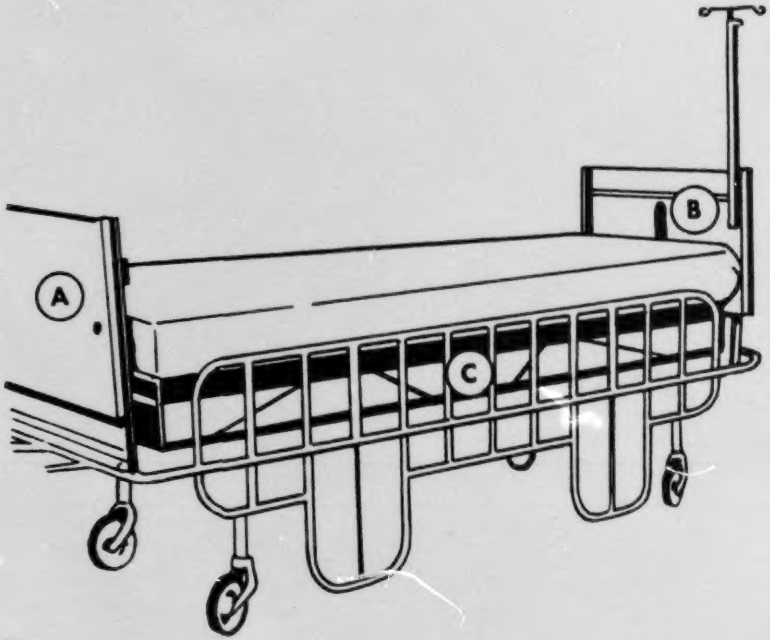
> For some patients, this restriction means that they do not go to the dining room for the evening meal, and ward personnel must therefore notify Food Service to provide tray service on the ward.

5–105. Preparation of Recovery Bed Unit

Routine preparation for postoperative patient care is completed while the patient is in the operating room. The patient unit is prepared to receive the patient, to include having in readiness any special equipment needed. In Army Medical Department hospitals, the patient is usually scheduled by the surgeon to go directly from the operating room to recovery ward until fully reacted from anesthesia; he is then returned to his assigned ward for continuing care. The medical specialist assisting with preparations for postoperative care should follow these preliminary steps:

a. Check the OR schedule. Note the type of operation and anesthesia listed. Discuss these facts with the head nurse or designated nursing team leader and review both general and special aspects of nursing care for the patient. This preliminary review of the proposed operation and anesthetic is a basic requirement for knowledgeable assistance with subsequent preparations.

b. Know what factors are considered in locating the postoperative patient unit within the ward. The optimum location may be in a multibed ward or in a single room. Other patient's units may have to be shifted; this must be done with minimum confusion. Important factors in the physical location of the unit include: the requirement for close and continuous observation of the patient; proximity to available in-wall oxygen, suction, and electrical outlets; and adequacy of space, light, and ventilation with no drafts.



Ⓐ FOOT BOARD (REMOVABLE), WITH TRACTION OPENINGS.

Ⓑ HEAD BOARD (REMOVABLE), WITH TRACTION OPENINGS.

Ⓒ OPERATING INSTRUCTIONS (PRINTED PANEL ON CENTER OF BED FRAME).

Figure 5–78. Anesthesia recovery bed.

PREPARATION OF THE PATIENT UNIT

Start with a clean, freshly washed bed. The bed may be the standard hospital bed or a special "recovery bed" (Hill-Rom type, fig. 5-78).

Equipment

For The Bed
- Sheets, 4
- Laminated cotton drawsheet, 1
- Rubber treatment sheet, 1
- Pillowcases, 2
- Pillows, plastic covered, 2
- Cotton blanket, 1
- Siderails, 2

For The Bedside Stand
- Bath towel, 1
- Hand towel, 2
- Washcloth, 1
- Paper bag
- Emesis basin
- Box of Tissues
- Mouth wedge (prepared by taping together 2 tongue blades and padding one end with gauze)

Sphygmomanometer
Stethoscope
Pencil and paper

Procedure (Standard Hospital Bed)

1. Place the bottom (foundation) sheet and the drawsheet in the usual manner.
2. Place the rubber treatment sheet to protect the upper third of the foundation. Cover the rubber sheet with a cotton sheet folded hem to hem, and placed so as to overlap the drawsheet by 3 to 4 inches. This head-of-the-bed protection is provided to protect the foundation sheet from soiling by vomitus. It is an optional measure when no vomiting is anticipated; for example, in preparing the bed for a fully reacted patient returning from the recovery room.
3. Place the top sheet and blanket as for the unoccupied bed (para 5-12). Do not tuck under at the foot of the bed.
4. Fold the sheet over the blanket to form a cuff at the head and at the foot of the bed, with the fold at the foot of the bed even with the mattress.
5. Fan-fold the cuffed top covers lengthwise to the far side of the bed (the side away from the room entrance).
6. Fit the pillows into the pillowcases. Place one pillow upright at the head of the bed, securing the ends between the rungs. Place the second pillow on the chair.
7. Arrange equipment on the bedside stand.
8. Move the bedside stand and chair to provide space for a stretcher parallel to the bed on the side facing the entrance.
9. Attach bedrails and leave in down position.

Other Needs

1. Obtain other equipment that may be needed and place in readiness at the bedside: IV stand; sterile urinary drainage bottle and tubing; oxygen equipment; suction apparatus.

NOTE

One of more types of suction apparatus may be required; *for example*, one for gastrointestinal suction and one for airway.

2. Make sure all apparatus is in working order before the need to use it arises, in order to avoid loss of time and distraction of attention from the patient.

5-106. Postoperative Nursing Care

Nursing measures to prevent complications, to prevent and relieve postoperative discomforts, and to promote early restoration of normal body functions are begun as the patient is transferred from the operating room to the designated patient unit. Postoperative nursing measures may be classified as (1) immediate care measures, applied while the patient is reacting (regaining full consciousness) from anesthesia, and (2) early care measures applied following reaction from anesthesia, when the patient is conscious and able to respond to specific requests and directions. In most AMEDD hospitals, the patient receives immediate and early care in the surgical recovery unit (recovery ward); the nursing care that is begun in the recovery ward is continued when the patient is transferred to a general (or specialized) postoperative ward. The enlisted specialist who is assisting with care of the postoperative patient must understand that while different phases of care—immediate, early, and progressive convalescent as the patient becomes self-sufficient—are usually carried out in different ward settings, all phases are part of the total care of the patient, and none are considered as unrelated segments.

5-107. Immediate Postoperative Care

a. General. This is care given on reception of the patient from the operating room and continued until the patient is fully conscious and has regained his protective reflexes (gagging, swallowing, and purposeful movements). During this period, observe the following general precautions:

(1) Never leave a patient alone, unobserved, and unattended during the period of recovery from anesthesia.

(2) Be constantly alert to the possibility of respiratory obstruction, shock, and hemorrhage. The period of recovery from anesthesia and the first few hours after surgery are periods of danger. Report any signs noted and any doubts about any sign or symptom.

(3) Be aware of specific orders to be carried out, specific symptoms for which to be alert, and any complications which may develop and which may modify any of the general nursing care measures discussed in this section.

NOTE

> Immediate postoperative nursing care is customarily under the direct supervision of a professional nurse, who evaluates the patient's condition, checks orders, sees that they are carried out, instructs the enlisted specialist who is assigned to help care for and stay with the patient, and keeps the enlisted assistant informed.

As soon as possible, the enlisted specialist reviews and discusses the operative procedure, the postoperative orders, and the patient's condition with the nurse so that he is fully informed and can therefore be of maximum assistance; this discussion should not take place at the patient's bedside.

b. Transfer of Patient From OR Stretcher to Recovery Bed. An anesthetist customarily accompanies all anesthetized patients, supervises and assists with the transfer and positioning, and alerts ward personnel to specific precautions. Unless you are otherwise ordered, observe the following precautions:

(1) Lock bed wheels before transfer is started.

(2) Prepare to assist with a 4-man, lift-sheet transfer (fig. 5–79).

(3) Follow anesthetist's instructions and signals to coordinate all movements.

(4) On signal, lift gently and smoothly. Jarring the patient's body and rough handling may overtax his circulatory system and be a factor in producing shock. The control of lifting and trans-

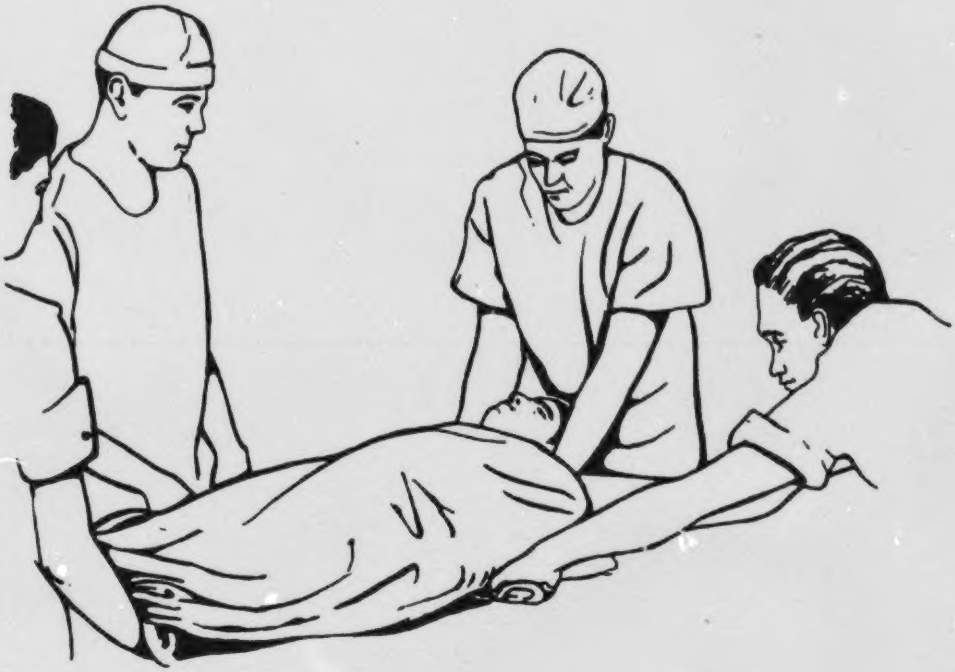


Figure 5–79. The 4-man lift sheet transfer.

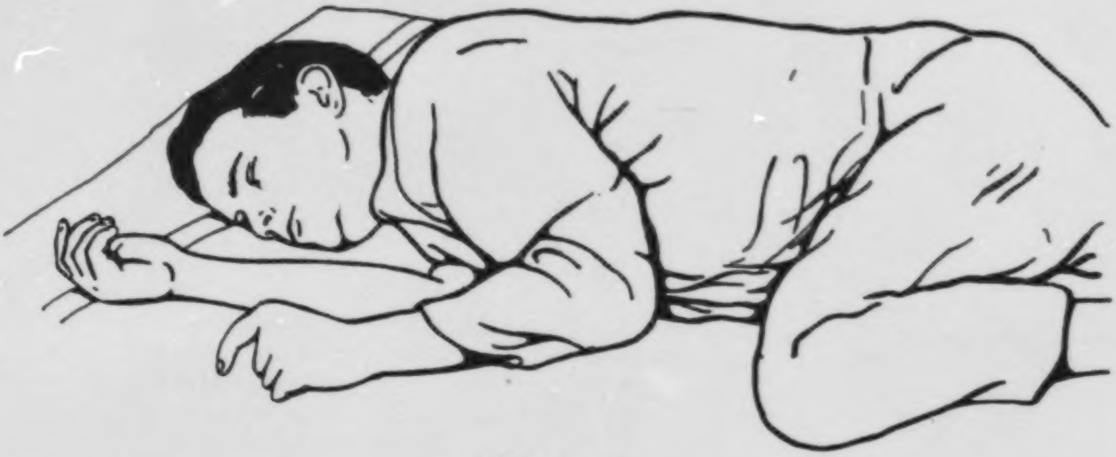


Figure 5–80. Lateral position.

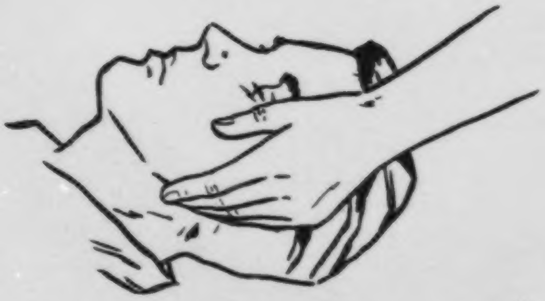
ferring movements is so important that the bed is brought to the OR for some patients in order to minimize handling.

(5) Use good body mechanics. Keep the patient's body straight, supporting head and extremities. Avoid straining yourself. Designate the tallest assistants with the longest arms for the lifting posts at either side of the bed and stretcher.

(6) Remember that the anesthetized patient must have his relaxed extremities and joints supported and kept in good alinement to prevent nerve damage from pressure and to protect muscles and joints from strain. Do not allow arms or legs to dangle during any lifting and moving procedure.

c. Assist With Positioning the Patient in Bed. Unless contraindicated, the preferred position for the patient while he is recovering from a general anesthetic is on a flat bed, in the lateral position (fig. 5–80). Place a pillow at the back to support the patient and allow the patient's shoulders and back to rest on this support. In turning and changing his position, protect and support the joints. Do not position the patient when on his side so that he is lying on his shoulder and arm—bring the shoulder and arm forward or backward to relieve pressure. Turn his face to the side, with chin extended, and flex his legs slightly at the knee, with the upper leg forward to help maintain position.

d. Maintenance of a Patent Airway. Proper positioning will often assure a patent (open, unobstructed) airway. It may be necessary to hold the lower jaw forward (fig. 5–81) to prevent the tongue from falling back into the throat. Place the fingers behind the angle of the jaw; push the jaw forward as if bringing the lower teeth in front of the upper. If necessary, grasp the tongue with a gauze sponge and pull it forward.

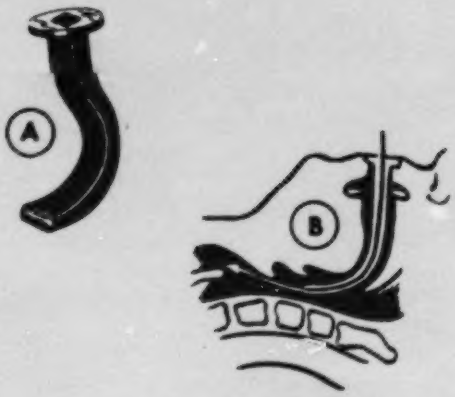


PLACE THE FINGERS BEHIND THE ANGLE OF THE JAW; PUSH THE JAW FORWARD AS IF BRINGING THE LOWER TEETH IN FRONT OF THE UPPER. IT MAY BE NECESSARY TO GRASP THE TONGUE WITH A GAUZE SPONGE AND PULL IT FORWARD.

Figure 5–81. Holding jaw in place.

(1) *Artificial airway.* The anesthetist inserts this curved device (fig. 5–82 Ⓐ) to hold the tongue forward and insure unobstructed breathing. Leave it in place until the patient indicates return of his protective swallowing reflex by gagging or pushing at the airway with his tongue. In removing the airway, follow the curve (fig. 5–82 Ⓑ) to avoid injury to the throat.

(2) *Respirations.* Observe and note respirations. Pay immediate attention to noisy, snoring respiration; these usually indicate the relaxed



IF THE PATIENT HAS HAD AN AIRWAY (A) INSERTED (B) DURING SURGERY, IT IS LEFT IN PLACE UNTIL THE PATIENT ATTEMPTS TO COUGH IT OUT.

Figure 5-82. Airway in place.

tongue has fallen back into the throat and is obstructing the airway. If this occurs—

(a) If movement of the patient is permitted, immediately roll patient from his side to his abdomen with his head down over the side of the bed. This will allow the relaxed tongue to fall forward.

(b) If patient cannot be turned, open the patient's mouth and pull his tongue forward. To do this, locate the angle of the jaw bone, press forward on the angle with thumbs and down on the chin with fingers to separate the teeth. Place the padded mouth wedge between the back teeth when the mouth has been opened. With gauze-wrapped fingers, grasp the tongue and pull it forward.

(3) *Suction.* Use suction when required to clear secretions from the throat.

(4) *Vomiting.* Stay with and assist the patient during vomiting. Keep head turned to side, chin extended. Suction as necessary to prevent aspiration of vomitus into the trachea. If an emesis basin is not on hand, do not leave the patient unattended in order to get one—soiled bed linen can always be changed when the vomiting emergency is over.

e. Dressing. Locate and check condition of dressing. Inspect the top layer, at the sides and beneath the patient to detect any oozing. Continue observations at frequent intervals. Look for blood stains on the bottom sheet, and note and report immediately the character and amount of bleeding or any drainage. Reinforce top layer of dressing if necessary, but never remove any original layers.

f. Drainage Tubing and Catheters. Locate and check all drainage tubing and catheters. Follow orders for unclamping and connecting to drainage bottle or suction. (Urinary catheters are usually attached, unclamped, and allowed to drain immediately. Chest catheters are attached to drainage or suction by the surgeon.)

(1) Secure tubing to bed as required to prevent tension and permit movement of the patient.

(2) Check at frequent intervals to be sure all tubes and catheters are free of kinks, open (or properly clamped), and not collapsed by being caught under the patient's body or by being pinched in the bedrails.

(3) Note the character and amount of drainage and any changes.

g. IV Tubing and Needle Location. Check IV tubing and needle location. Keep flow at prescribed rate. Be alert to any signs or symptoms of reactions. Use an arm board to prevent needle displacement if the patient is restless.

h. Vital Signs. Take pulse, respiration, and blood pressure while anesthetist is still present. Report initial measurements verbally to the anesthetist and record them on the bedside record. Take and record pulse, respiration, and blood pressure at specified intervals, usually every 15 minutes until otherwise ordered. Report any marked variations at once.

(1) *Pulse.* Count pulse for 1 full minute. Note rate, quality, and character. Report a pulse above 90, one below 60, and sudden increases or decreases verbally as well as by recording.

(2) *Respiration.* Count respirations for 1 full minute. Respirations should be quiet, effortless, deep, and uniform (16 to 20 per minute). Report any changes in rate, rhythm, and sound. Stay constantly alert to changes indicating an obstructed airway.

(3) *Blood pressure.* To evaluate postoperative blood pressure, the usual preoperative blood pressure should be known. As a general rule, the desired systolic BP for an adult is 100 and above, with very little fluctuation. (The BP cuff is kept in place on the patient's arm when BP is being checked frequently in the postoperative period.)

(4) *Temperature.* Take rectal temperature with initial vital signs measurements and at least

every 4 hours thereafter for the first 24 hours. Thermometer must be held in place for unconscious patient.

(5) *Skin color and temperature.* Note color, warmth, moisture, and general appearance (blotchy, rash, or reddened areas). Cold, moist ashen skin and pale color of lips, conjunctiva, and nailbeds are important signs of unstable circulation and possible lack of oxygen. With dark-skinned individuals, note particularly the color of nailbeds, temperature of finger and toe tips, and color and skin temperature of ear lobes. These checkpoints indicate adequacy of peripheral circulation.

i. State of Reactivity. Note the patient's state of reactivity. The term reactivity refers to the patient's return to consciousness (awakening) following the administration of a general anesthetic. He is said to be fully reacted when he is fully conscious. With modern methods of administering anesthesia, many patients have begun to react on return from the operating room. Partial reaction may therefore take place within a few minutes after surgery is completed, although full return to consciousness takes longer.

(1) *Signs of partial reactivity.* The patient begins to move his extremities, swallows, blinks his eyelids, and moves his tongue in attempt to expel an airway if one is present. He may groan or speak a word or two. During this period, you should—

(*a*) Always continue close observation and be in constant attendance. Vomiting may occur and the danger of aspiration is great.

(*b*) Speak reassuringly. Call the patient by name in a low, calm voice. Tell him the operation is over and that he is back in his bed again. Avoid loud noises. Avoid conversation at the bedside. Be exceptionally careful about what is said within his hearing. He may appear very groggy and cannot respond appropriately, but he can often hear and remember remarks made when he is only partially conscious.

(*c*) Control his involuntary, restless movements by gentle hand pressure or by tucking in the top covers snugly but not tightly. Increasing restlessness must always be reported immediately—this may be a sign of impending hypoxia or possible hemorrhage. As the patient begins to move about, check vital signs stat. for any variations from previous measurements. Check position and functioning of drainage tubes for possible displacement. Check dressing for bleeding or loosening of adhesive.

(2) *Signs of full consciousness.* The patient will make coordinated movements in response to definite requests—*for example,* he will squeeze your hand on request, take a deep breath, attempt to whistle, answer to his name, understand questions, and show he is oriented to time and place by remembering where he is and perhaps by recognizing personnel and remembering their names.

CAUTION

Protect the partially conscious or fully conscious but groggy patient, from falling out of bed. Use bedrails as well as close observation. Leave bedrails in up position at all times on the unattended side of the bed and to the maximum extent possible on the attended side.

(3) *Special observations for spinal anesthesia.* With spinal anesthesia the patient remains conscious, although he is usually drowsy from preoperative medication. In addition to having numbness of the trunk and extremities, he may have respiratory or circulatory depression, so he must be observed closely until vital signs become stable. He must have specific care measures because of the operative procedure but you must also observe the following precautions:

(*a*) Be alert to all irregularities in vital signs.

NOTE

It is not unusual for the blood pressure to be lower than normal during the immediate care period.

(*b*) Keep patient flat in bed until otherwise ordered (one pillow under the head may be permitted.) An initial supine position, careful turning, and no unnecessary movement for 6 to 12 hours may be ordered to minimize possibility of headache. Headache attributed to spinal anesthesia may occur 24 hours postoperatively.

(*c*) Note and record time of return of motion and sensation in lower extremities.

(*d*) Avoid pressure and strain on numb extremities. Support in good alinement.

5–108. Early Postoperative Care (After Patient Reacts)

a. General Precautions.

(1) Continue close observation of dressing.

(2) Make sure all drainage tubes are functioning.

(3) Be alert to any irregularities in vital signs as increased activities and nursing measures are started.

(4) Report observations immediately to the nurse or doctor for evaluation and additional instructions on modifications of care.

(5) Alternate periods of rest and activity as much as possible to allow your patient to recuperate from the mental and physical strain of the operation. During the first 24 to 48 hours the patient needs as much rest as he can obtain, but he must also be assisted and encouraged to carry out controlled exercises and activities that are absolutely necessary to prevent complications. Explain that he will benefit from activities that he may not feel ready for or that he fears may cause pain.

(6) Watch for and report immediately signs and complaints of pain. Medication for pain is usually given before the patient becomes intensely uncomfortable. When pain is relieved, he can relax and is better able to cooperate in moving and learning how to help himself toward recovery.

(*a*) Investigate possible contributing causes of pain and discomfort such as a need for position change, adjustment of drainage tubing, or easing of constricting binders or dressings. Appropriate comfort measures will enable the patient to receive maximum benefit from the prescribed drug.

(*b*) Medication orders usually are written for some narcotic and the order is apt to be for p.r.n. administration, indicating that the doctor is relying on the knowledge and judgment of the nurse. It is accepted policy that such medications are given only by the nurse or under the direct supervision of the nurse. In reviewing the written orders, you should note that there is usually a reduced dosage of narcotics, hypnotics, or any drug with a sedative or tranquilizing effect for the immediate or early postoperative patient. The amount of drug may be increased in a subsequent order as the patient's condition becomes stabilized and the lingering effects of the anesthetic wear off. Meperidine hydrochloride is an example of a narcotic drug frequently ordered to relieve postoperative pain; it has effects similar to morphine but with less depression of respirations.

(7) Continue to use side rails on the bed when there is any doubt about the patient's alertness and orientation. Side rails also provide support and give the patient something to pull on as he learns to assist himself in turning.

b. General Nursing Measures. In many respects, postoperative nursing measures parallel those employed for any patient requiring skilled and intensive care. The care initiated in the immediate postoperative period and carried through day and night, for the first several postoperative days will often prevent serious complications and can mean the difference between the success or failure of the surgery performed. Unless otherwise ordered, the following are considered routine postoperative nursing measures:

(1) Provide comfort and hygiene care. Start by washing his face and hands. Allow patient to rinse his mouth with plain water when he is fully conscious. Elevate the head of the bed slightly unless orders are to lie flat. Place one pillow under the patient's head. As soon as possible, give him a partial bath since most patients will have perspired heavily. Rub his back with lotion and inspect all bony prominences for signs of pressure. Change damp or soiled linen, removing postoperative protective linen when no longer required. Put clean pajamas on, reversing the jacket back to front as necessary. Assist him to brush his teeth. Replace dentures as soon as possible as an aid to both mental and physical comfort.

(2) If nothing by mouth has been ordered, plan to give mouth care every 2 hours. Allow the responsive patient to rinse his mouth frequently with plain water; if he is not allowed to rinse his mouth, wipe his lips and tongue with wet gauze. When preoperative medication such as atropine sulphate has been given to help control secretions during anesthesia, excessive dryness of mucous membranes may persist for several hours postoperatively. The patient often feels as if he has a mouth full of cotton, and moisture for his mouth and lips is an important comfort measure.

(3) Assist with position changes, alternating back and side-lying position at least every 2 hours. Use good body mechanics. Show the patient how to move and change his position within permissible limits, with the least strain and discomfort. (Follow methods discussed in paragraphs 5-15 through 5-18 for position changes and maintenance of good body alinement.)

(4) Check functioning of drainage tubing and condition of dressing during and after each change in position.

(5) Encourage deep breathing to insure good lung expansion and aeration of lung tissue. Show

the patient how to breathe deeply by placing his hand on his abdomen to feel the pulling in of abdominal muscles with a deep inspiration. Tell him to take 10 such deep breaths every hour and check to see that this is done.

(6) Keep accurate record of intake and output.

(*a*) *Intake.* When oral fluids are permitted, start with sips of cool (not iced) water. As initial small amounts are tolerated, with no nausea or vomiting, encourage intake of water frequently but not excessively at any one time. Up to 200 ml. per hour taken in small amounts at a time may be permissible to help restore and maintain fluid balance. Because of fluid loss during surgery, parenteral fluids are often ordered during the first day to supplement oral intake. When a regular or other solid-food diet is ordered for the first or second postoperative day, encourage the patient to eat as much as he can of the food served. Some patients are very reluctant to eat, fearing nausea or vomiting, and they need encouragement. Do not be too insistent. Report progress or failure with food intake after each meal.

(*b*) *Voiding.* Note frequency and amount voided. Report immediately if patient has not voided within 8 hours following return from OR. The bladder may tend to hold accumulated urine for a longer period of time than usual following surgery, but after 8 hours, provision must be made to relieve the distended bladder and the discomfort that results from urinary retention. The doctor will order catheterization when necessary, but you may try other measures first. If permissible, get the patient out of bed. Help the male patient to stand to void; seat the female patient on a commode or place a warm bedpan on the chair. Apply warm moist towels to the suprapubic region and pour warm water over the genitalia.

(7) Assist the patient to cough effectively. Coughing is encouraged in order to clear mucous secretions from the bronchi, unless contraindicated (*for example,* following surgery on the eyes, brain or spinal cord when coughing may cause excessive internal pressure changes). If secretions are allowed to accumulate, they block the bronchi and prevent air from reaching lung tissue. Effective coughing, deep breathing, and change of position are all measures which help prevent atelectasis, a serious condition of lung collapse due to incomplete aeration of lung tissue. Atelectasis can occur within 24 hours postoperatively if preventive measures are neglected or not carried out effectively on the recommended hourly or every 2-hour basis. When coughing is prescribed, teach and assist the patient to cough effectively. It is often a painful experience and maximum assistance is needed. Otherwise the patient will try to suppress the cough or will "hack" or merely clear his throat. He can cough most effectively when sitting upright, with his incision firmly supported by manual pressure to prevent undue strain. The following method of assisting the patient is recommended:

To Assist Patient to Cough (Sitting Upright)

- Using good body mechanics, assist the patient to sit upright in bed. Provide him with a pull rope attached to the foot of the bed to help him to sit up and maintain his position. Looped web belts (stretcher straps or trouser belts) can be used for an effective pull rope.
- Hand him several tissues, folded in layers, to "cover the cough."
- Stand at his side, placing your hands firmly on either side of the incision. As an alternative to splinting the incision with the hands, use a bath towel folded lengthwise; center it over the operative area and grasp both ends.
- Instruct the patient to inhale deeply, to cough on exhalation, and to expectorate coughed-up secretions into the tissue. As he exhales and coughs, exert pressure on the incision with hands or towel splint.
- Repeat cough procedure. Three successive deep coughs are often necessary to clear the bronchi.
- Inspect used tissue to note secretions before discarding in bedside waste bag.
- Assist patient to comfortable resting position.
- If coughing procedure causes fatigue only and no production of sputum, report this immediately.

To Assist in Coughing When Patient Cannot Sit Up

- Turn patient to supine position, with head of the bed elevated to permissible limit.
- Remove restraining bed clothing from chest area.
- Proceed as in steps above.

(8) Assist with prescribed bed exercises and early ambulation to help restore normal functioning of all body systems. Both of these measures when started within 24 hours after surgery may prevent thrombus (clot) formation in the venous

circulation, particularly in the pelvis and lower extremities.

(*a*) *Bed exercises.* One recommended series of lower extremity exercises can be started as soon as the patient is permitted to move about in bed. (More specialized exercises are usually taught and supervised by physical therapy personnel.)

CAUTION

Loosen bed linen so that there is no constriction of legs or feet.

- Turn patient to supine position, with bed flat.
- Tell patient to: bend his knees, straighten his knees and, when legs are fully extended, try to push the backs of his knees hard against the mattress, holding this pushing movement for 5 seconds. Then tell him to relax, take two deep breaths, and repeat the movements at least 5 times.
- To check on his ability to do this active exercise, slip your hand, palm down, under the popliteal area when his leg is fully extended, and tell him to concentrate on pushing down the back of his knee against your hand.

NOTE

When done successfully, this part of the leg exercise is called quadriceps setting. Quadriceps setting is often prescribed when no other lower extremity movement is possible; it contracts thigh and calf muscles and helps maintain muscle tone and circulation. Encourage and remind the patient to repeat the "setting" exercise at least every 2 hours. Check on his ability to do it as instructed by supervising him at least every 4 hours.

(*b*) *Early ambulation.* Early ambulation means getting the patient out of bed and assisting him to walk (often within the first 12 hours postoperatively). This may be a very complex procedure, requiring a high degree of nursing skill and judgment. It must be done when ordered, while at the same time continuing treatment with IV fluids, drainage tubes, indwelling urinary catheters, and all other complicating treatment factors. In addition to the management of the understandably apprehensive and wobbly patient, all the treatment equipment must be maintained in operational order.

To Assist the Patient to Ambulate Postoperatively

- Check vital signs before getting the patient up. If in doubt as to the patient's condition, report observations to the nurse or doctor and request evaluation.
- If drainage tubes are present, find out which may be clamped off temporarily and which must continue to function. In general, nasogastric tubes may be clamped and disconnected from the drainage bottle but urine-drainage catheters are left open, to continue to drain into a portable drainage bottle.
- If IV fluids are to continue, secure the patient's arm to an arm board. Hold the bottle at shoulder height or hang it on a mobile pole and push the pole as the patient walks.
- Check dressing and reinforce as necessary. If a binder is used, make sure it is applied smoothly and securely while the patient is flat in bed to provide the required support.
- If supporting elastic bandages or stockings are ordered, apply them while patient is in bed and supine.
- Dress patient in pajamas and robe. Secure all fastenings so that there will be no exposure and so they will fit properly, in order to avoid having the patient worrying about holding up his trousers while attempting to stand and walk.
- Provide well-fitting slippers or shoes so that the patient can walk and not shuffle. If muslin scuffs are used, select an appropriate size and tie them securely.
- Using good body mechanics, assist the patient to sit upright at the side of the bed. When he feels secure, assist him to stand at the side of the bed. Have an assistant present if needed.
- Stand beside the patient and walk close to him. Encourage him to stand upright and to breathe deeply. Most patients tend to bend over, to clutch their incision, and to be understandably apprehensive. A recommended method to provide maximum support for a weak patient is to link arms so that the patient's palm is up and the assistant's palm is down. If the patient starts to sway or lose balance, the assistant can immediately slide his arm up into the patient's axilla and balance the patient against his hip.
- Assist the patient to walk the recommended distance before returning him to a chair or to bed.

5-109. Postoperative Complications

The complications discussed in this section are not limited to postoperative situations—they may occur with other conditions of disease and injury. It is important to remember that when resistance is lowered, as it is following surgery, complications can develop and one complication can follow another. Good preoperative and postoperative care prevents many of the complications that were once fairly common. The skilled medical specialist should know the types of complications which may occur, actions he can take to help prevent them, the significance of early signs and symptoms, and the basic principles of treatment. Complications to be particularly aware of are shock, hemorrhage, circulatory problems (other than shock and hemorrhage); respiratory problems; gastrointestinal problems, and fluid balance problems.

SHOCK

a. Definition and Causes. Shock is a body reaction to injury or disease; it is a condition in which there is not enough blood in circulation, to fill the vascular system. As a result of ineffective circulation there is interference with the basic physiologic process of the blood stream—delivering oxygen and other essential elements to body tissues and removing waste products. Reduction of blood volume in circulation can result from—

(1) Actual loss of blood through internal or external hemorrhage.

(2) Loss of plasma, the fluid part of blood, by seepage into tissues at the site of injury, as in burns, contusions, and crash injuries.

(3) Excessive loss of fluids and electrolytes from the intestinal tract through severe vomiting, diarrhea, and continued gastrointestinal suction.

(4) An abnormally sudden increase in the capacity of the vascular system (vasodilation). Many blood vessels dilate at the same time and, although there is no actual loss in the amount of blood, blood fails to move along in the dilated vessels.

b. Signs and Symptoms. The signs and symptoms of shock are all related to ineffective circulation and depression of vital body processes. The signs and symptoms listed below may not be equally prominent or appear in every patient, but they are representative of the picture presented of the patient in shock (fig. 5–83).

(1) Pale, cool, moist skin.

(2) Falling blood pressure.

(3) Weak, rapid, thready pulse.

NOTE

A progressively falling blood pressure combined with increasing pulse rate are two of the most important signs.

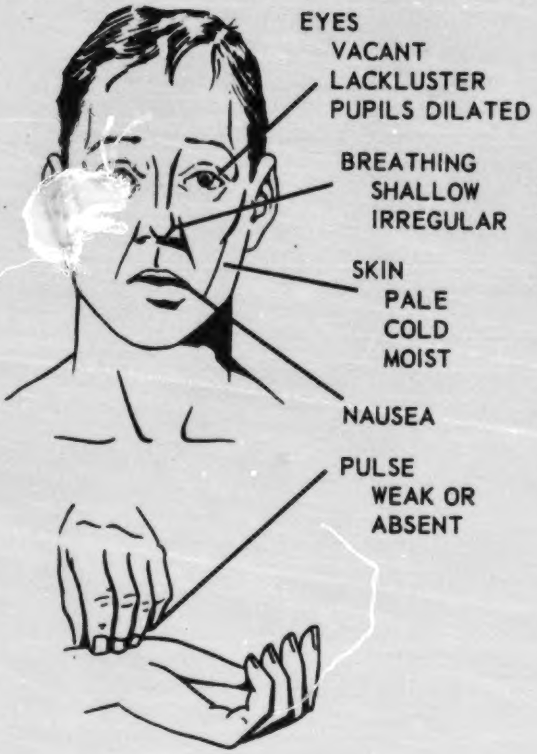


Figure 5–83. Patient in shock.

(4) Rapid, shallow respirations.

(5) Anxiety, changing to listlessness and apathy.

(6) Staring or vacant expression in the eyes. The pupils are apt to be dilated unless morphine has been given recently.

c. Prevention Measures. Shock should be anticipated in all individuals subjected to known causes of shock—physical and emotional stress, any severe injury, loss of blood, or loss of other body fluids. Accident victims and postoperative patients are in this category. Shock may develop slowly; the characteristic signs may not appear for several hours. In incipient or impending shock (shock that has not yet developed), none of the signs may be present, but preventive measures should be taken as follows:

(1) Keep patient horizontal so that available circulating blood does not have to move against gravity. If the patient must be moved, move him gently.

(2) Cover lightly to conserve body warmth. Avoid overheating because this contributes to dilation of peripheral blood vessels.

(3) Use prescribed sedative and analgesic drugs cautiously. Relief of pain is desirable, but these drugs also tend to depress the mechanisms of the central nervous system which control and maintain blood pressure.

(4) Maintain a quiet, calm atmosphere to reassure the patient and make him feel secure.

(5) Observe vital signs frequently and regularly to detect irregularities and sudden changes.

d. Treatment Measures. While complete treatment depends upon the underlying cause, emergency measures include the following:

Treatment Measures for Shock

1. Place two pillows beneath the patient's feet, with flexion at the knees. This will create pooling of blood in the abdomen without pressure on the diaphragm.

EXCEPTION to shock position: head surgery and spinal anesthesia patients should remain horizontal unless otherwise ordered.

2. Keep airway clear.
3. Stay with the patient. Send for help. Do not leave the patient unless a competent person is present to stay with him until you return.
4. Be prepared to assist with IV and blood transfusion.
5. Be prepared to assist with oxygen therapy by mask or catheter. Start oxygen administration immediately at 6 liters per minute if cyanosis of lips, nailbeds, or earlobes is noticed.
6. Maintain close watch on urine output. Note amount and time of each voiding. If urinary catheter is used, note hourly output. To measure hourly output from a urinary catheter, tape a 30 ml. or 50 ml. Luer syringe barrel to the side rail of the bed. Attach drainage tube leading to a large collecting bottle to the tip of the syringe, and clamp this tube. Place the free end of the drainage tube leading from the catheter just within the open end of the syringe barrel. After reading and recording the urine measurement in the syringe barrel, release the clamp to allow the urine to enter the large collecting bottle. Reapply the clamp until the next scheduled interval for reading and recording urine output.
    a. An hourly output measurement is often ordered whenever there is a condition of oliguria (diminished urine secretion) or suspected anuria (absence of urine secretion).
    b. A critical point for effective kidney function is reached when systolic blood pressure drops below 80 mm. of mercury. Failure of the kidneys to form urine (renal shutdown) may result and continue after the blood pressure returns to normal. This may be a fatal complication. A general rule to observe in caring for all patients who have been in shock is: if after 2 hours of normal blood pressure, no urine or less than 25 ml. per hour is obtained, report this finding immediately to the doctor or nurse.
7. Maintain close watch as shock treatment measures are discontinued gradually when vital signs return to normal and become stable. One valuable test of return of circulatory control is the ability of the patient to maintain stable vital signs as his position is gradually changed from shock position to horizontal, to a slight elevation of his head. No sudden or abrupt movements are permitted.

HEMORRHAGE

a. General. Hemorrhage is bleeding from blood vessels due to a break in their walls. Realization of the possibility of delayed hemorrhage occurring either externally or internally as a postoperative complication is of utmost importance. During the operation, the surgeon controls the bleeding by pressure on oozing capillaries and very small vessels and by ligating (tying off) larger vessels. Reactionary (secondary) bleeding may occur within a few hours after the operation when circulation and blood pressure return to normal; owing to the depressing effect of the anesthetic on circulation, bleeding from capillaries may be very slight during the operation but increase considerably as the effect of the anesthesia wears off and the heart beat becomes stronger. This increased blood pressure may also cause bleeding by displacing blood clots previously formed or may even cause a ligature to slip from a large vessel. The patient may lose small amounts of blood over a relatively long period of time or a large amount (500 ml. or more) in a sudden massive hemorrhage.

b. Signs and Symptoms.

(1) Visible evidence of hemorrhage is noted by—

(*a*) Inspecting dressings.

(*b*) Inspecting the bedding under the patient.

(*c*) Noting presence of blood in vomitus, sputum, urine, feces, and drainage from tubing or catheter.

(*d*) Noting color change of drainage from the dark red or brownish color of old blood to the bright red of fresh blood.

(2) Evidence of internal bleeding is detected by keen observation. Be alert for symptoms of—

(*a*) Restlessness.

(*b*) Thirst.

(*c*) Apprehension.

(*d*) Increasing pulse rate.

(*e*) Falling blood pressure.

Treatment Measures for Hemorrhage

1. Notify nurse or doctor. Send for help. Stay with the patient unless competent help is present to relieve you while you obtain emergency equipment or other supplies.
2. Do not disturb or remove any part of the dressing. If external surface is blood-soaked, reinforce by placing large, dry, sterile compresses over it.
3. Save all evidences of bleeding for estimation of blood loss. This includes linen, emesis basin containing vomitus, and bedpan containing stool. Remove these from the bedside to lessen the patient's apprehension, but do not discard until so ordered.
4. Keep noise and confusion to a minimum.
5. Treat for shock.
6. Be prepared to assist with immediate transportation of the patient to the operating room.
7. Be prepared to assist with blood transfusion. Multiple units of blood (2500 ml. to 3500 ml. or more) may be necessary.
8. Be prepared to assist with blood plasma, dextran, or electrolyte solution infusion. The type, speed, and the sequence in which all IV fluid replacements are given are always determined by the doctor.
9. In hemorrhage from the gastrointestinal tract, be prepared to assist with gastric intubation if a tube is not already in place. Ice water irrigations of the gastrointestinal tube may be ordered or an enema to clear accumulated old blood from the rectum and lower bowel.

CIRCULATORY PROBLEMS

Thrombophlebitis

Thrombophlebitis is inflammation of a vein with blood clot formation. Venous stasis (slowing of venous blood circulation) and pressure or other injury to vein walls predisposes to its development. The most common sites for development of thrombophlebitis are in the veins of the pelvis and legs. A postoperative patient or any other individual who has remained still for hours at a time, with relaxed muscles and a resultant slowing of venous circulation in the legs, is particularly liable to develop thrombophlebitis; when inactivity is combined with pressure on the popliteal space and the calf of the leg, the possibility of developing it increases.

a. Signs and Symptoms of Thrombophlebitis.

(1) Cramping pain in the calf.

(2) Possible redness, warmth, and swelling along the course of the involved vein.

(3) Pain which may appear only on dorsiflexion of the foot.

b. Treatment Measures.

(1) Do not under any circumstance rub or massage the affected limb.

(2) Place the patient on immediate bed rest and notify the medical officer.

(3) Keep affected limb horizontal and at rest until the medical officer has examined the patient and ordered specific treatment. Support the entire limb from the thigh to the ankle on pillows, keeping the limb level unless otherwise ordered. Orders for treatment may include elevation and application of continuous, massive, warm, moist packs to the entire limb.

(4) Use a bed cradle to prevent any pressure from the bed linen.

(5) Be alert to any complaint or other evidence of respiratory difficulty or chest pain. A clot which is adherent to the vein wall, or a portion of a clot, can become dislodged and be carried in the circulation as an embolus to distant and smaller arterial blood vessels in the lungs. Sudden dyspnea, violent coughing, or severe chest pain may be the first sign or symptom of embolism.

(6) Discontinue routine postoperative exercise, ambulation, deep breathing, and coughing measures until the medical officer has indicated which measures are to be resumed and which precautions are taken.

(7) Carry out all subsequent treatment and nursing care measures so as to avoid abrupt movements and any strain on the part of the patient.

(8) When ordered, apply bandages to give support and aid venous circulation:

(*a*) Use a 3-inch or 4-inch cotton elastic bandage. Two or more are usually required for each extremity.

(*b*) Apply bandage with the patient supine and his foot supported in a neutral position (slight dorsiflexion).

(*c*) Start just proximal to the toes and apply smoothly and snugly, overlapping each turn evenly to avoid any constriction or pinching of skin from bandage edges. Include the heel. Wrap from toes to 1 inch below the bend of the knee, or include all of the thigh to the groin, according to orders.

(*d*) Remove bandages at least once daily to care for and inspect the skin. Wash and dry the involved area using gentle stroking motions, but no patting or rubbing motions. Report immediately any evidence of pressure, wrinkles or edema.

(*e*) Reapply clean, resilient bandages following skin care and inspection of all skin areas. Cotton elastic bandage loses its resilient quality in use, but it can be laundered and its resilience maintained for several reapplications. Send used bandages to the laundry, preferably in a mesh bag. Obtain fresh bandages from CMS. Do not use a bandage that is not resilient—it will bind and restrict circulation instead of aiding it.

(9) When patient is allowed out of bed, remind him to alternate walking and resting with feet propped on a stool to avoid pressure in the popliteal space. Prolonged standing or sitting with no movement must be avoided. Check to see that the edge of the chair seat does not press the popliteal space and that the patient does not sit with crossed legs.

Embolism

An embolus is a blood clot or other foreign particle (fat globule or air bubble) floating in the bloodstream. The embolus is usually undetectable until it suddenly lodges in an arterial blood vessel. This may occur when the patient is apparently convalescing and progressing normally. If the embolus is sufficiently large and the arterial vessel which it obstructs supplies a vital area in the lungs, heart, or brain, the patient may die before any symptoms of embolism are detectable. A special type of embolism, pulmonary embolism, is caused by the obstruction of a pulmonary artery by an embolus. The most frequent cause of a postoperative pulmonary embolism is a thrombosed vein in the pelvis or lower extremities. Therefore, measures to prevent development of thrombophlebitis are the most important ones to take to prevent the possibly fatal complication of pulmonary embolism.

a. Signs and Symptoms.

NOTE

May or may not be observable.

(1) Sudden signs of shock and collapse.

(2) Sudden, sharp, stabbing chest pain.

(3) Sudden violent coughing and hemoptysis (spitting of blood).

b. Treatment Measures.

(1) Call the doctor.

(2) Insure absolute bed rest. Elevate head of bed to relieve respiratory distress.

(3) Prepare to start oxygen by mask at 6 to 8 liters per minute.

(4) Take and record blood pressure, pulse, respiration.

(5) Prepare to give medication by injection to relieve pain and acute apprehension. A narcotic drug such as morphine sulfate or meperidine hydrochloride is often ordered; if ordered for IV injection, it is given by the doctor.

(6) Prepare to continue intensive nursing care and constant observation. (The total care of the patient who survives a pulmonary embolism is similar to that of a patient who has had a myocardial infarction.)

NOTE

Anticoagulant drug therapy in thrombophlebitis and embolism.

Anticoagulant drugs such as heparin sodium and coumarin compounds lessen the tendency of blood to clot. They are frequently ordered as a part of the medical management of patients who have developed thrombophlebitis or who have survived an embolism. These drugs do not dissolve thrombi which have already formed but are an important treatment measure to prevent extension of a clot within a blood vessel or to prevent further intravascular clot formation. Anticoagulant drugs act by prolonging the clotting time of blood. Since a patient who has once developed thrombophlebitis may have a recurrence, he may be continued on an anticoagulant drug indefinitely as a prophylactic measure. Nursing personnel have a responsibility to recognize that any patient receiving an anticoagulant drug must be observed closely for any bleeding from a body opening—mouth, nose, urinary tract, or rectum. Individual patients differ widely in their response to anticoagulant drugs and if bleeding occurs, the doctor must be notified at once and the drug discontinued. Drug dosage is regulated very carefully by the doctor in relation to the individual patient's prothrombin determination, a laboratory test which requires obtaining a blood specimen by venipuncture. Certain drugs should not be given with anticoagulants. Aspirin and aspirin-like drugs increase the effect of the anticoagulant. Phenobarbital and phenylbutazone (butazolidine) decrease the effects of the anticoagulant. Because of the potential hazards of anticoagulant drug therapy and the complicated dosage orders to be followed, local policy often states that only the nurse may administer the drug. The medical specialist should know which patients are receiving an anticoagulant, be alert for any bleeding tendency, and report his observations immediately.

RESPIRATORY PROBLEMS

a. Prevention. When preventive measures have been carried out during the immediate and early postoperative periods, the possibility of atelectasis and of pneumonia developing are greatly reduced. Keeping the airway clear to prevent aspiration, deep breathing, coughing, turning and changing the patient's position q.2 h., and early ambulation are all basic measures to prevent respiratory complications. In addition to these routine postoperative measures, it is important to emphasize protecting the patient from contact with personnel, visitors, or other patients who may have an upper respiratory infection.

b. Special Preventive Treatment Measures. Patients with chronic respiratory diseases, elderly patients, children and infants, or brain damaged adults who cannot follow verbal instructions, and any patient whose movements are necessarily restricted because of the kind of surgery performed often need treatment measures in addition to routine preventive measures to help them to cough and clear their bronchi of secretions. Special treatment measures ordered may include—

(1) Steam inhalations or nebulized cool-vapor inhalations. Increased moisture in the inhaled air helps to liquify accumulated secretions and facilitates coughing them up to clear the air passages.

(2) Intermittent positive pressure breathing (IPPB) treatments with special apparatus to administer nebulized medications and moistening agents.

(3) Deep intratracheal suction to stimulate the cough reflex. This is suction by a nasal catheter which is passed down into the trachea to the bronchial area. A doctor or a nurse is responsible for this type of suctioning.

(4) Bronchoscopy, an operative procedure, to remove secretions which cannot be coughed up and which are blocking the air passages.

(5) Tracheostomy, an operative procedure, to insure an open airway which must be kept open by suctioning. A tracheostomy is sometimes performed during the initial surgery when the surgeon anticipates difficulty in maintaining a clear airway postoperatively.

c. Signs and Symptoms of Developing Respiratory Problems.

(1) Temperature elevation 24 to 48 hours postoperatively.

(2) Pain in chest.

(3) Cough.

(4) Dyspnea.

d. Treatment Measures for Respiratory Complications.

(1) Increased attention to all preventive measures.

(2) Antibiotic therapy.

(3) Isolation.

(4) Bed rest, or a combination of bed rest and ambulation.

(5) Oxygen and other forms of inhalation therapy.

GASTROINTESTINAL COMPLICATIONS

a. General. A certain amount of nausea and some initial vomiting may follow general anesthesia, but are not inevitable; many patients do not experience these once-anticipated discomforts. However, when they do occur and persist beyond the immediate anesthesia recovery period, treatment is started to combat their effects. Persistent nausea seriously reduces the possibility of the patient taking adequate fluid by mouth; excessive vomiting causes both dehydration and loss of electrolytes. Treatment orders may include parenteral medication to relieve nausea, IV fluids to replace electrolytes and relieve dehydration, and gastrointestinal intubation and suction to rest the gastrointestinal tract. Basic nursing measures which are helpful include maintaining a quiet, cool, odor-free environment; gentle handling and no abrupt position changes since motion tends to increase nausea; and reassurance.

NOTE

The young military patient often becomes nauseated from a prolonged period without eating. Food or fluid as soon as permitted will generally relieve his symptoms immediately.

b. Failure of Peristalsis. Acute dilation of the stomach and paralytic ileus sometimes occur when there is an accumulation of gas and fluid which the stomach and small intestine are unable to pass along because of a failure of normal peristalsis. This complication may develop 2 to 4 days postoperatively and cause great discomfort or pain. Almost immediate relief is obtained by intubation (accomplished by the doctor) and suction for decompression of the dilated stomach and small intestine. The ability of the patient to expel flatus (gas) by rectum is an indication that normal peristalsis is being re-established.

c. Fluid Balance Problems. The major nursing responsibility in maintaining fluid balance and preventing fluid balance problems is a constant awareness of the necessity for maintaining an accurate intake-output record (para 5-46). Follow all medical orders for fluid and nutrition therapy. Be alert to the patient's acceptance of his prescribed diet. Report problems immediately.

5-110. Tracheostomy Nursing Care

Tracheostomy is a surgical procedure performed to provide an unobstructed airway. In the hospital setting it is usually done in the operating room, although in extreme emergency it may be done at the bedside. Following establishment of the airway, a tracheotomy cannula (tube) made of silver metal or of plastic material is inserted. Essential postoperative care always includes frequent and gentle aspiration of the tube and the trachea to keep them cleared of accumulating secretions.

a. Tracheal Cannula Set. The cannula set includes a 3-part tube set (fig. 5-84 Ⓐ and Ⓑ) and a tracheal dilator (fig. 5-84 Ⓒ), a type of retracting instrument.

(1) The outer tube has a slotted flange on either side, to which tapes are tied, and a small lug (lock).

(2) The inner tube fits into the outer one and is locked in place when the lock is moved to down position.

(3) The obturator is used by the surgeon as a guide when inserting the outer cannula into the tracheal incision.

(4) The dilator is used to hold the edges of the incision apart so that the outer tube can be inserted.

(5) In routine care of the tracheotomy tube, the inner tube is removed by nursing personnel for cleansing; the outer tube is removed only by the physician. Care must be taken not to damage or drop any part—if bent or dented, it will not fit properly and the parts of one set are not interchangeable with parts of another.

(6) The obturator of the set in use and a dilator for emergency use must always be kept, clearly marked, at the patient's bedside; both should accompany the patient when he is transported away from his bed unit.

b. Preparatory Nursing Measures. In addition to routine preparation of the patient unit for postoperative care, the following measures for tracheostomy care require advance planning:

(1) *Constant attendance.* The patient will require constant attendance for at least the first 48 hours. The medical specialist must always remember two things: that the patient's life depends upon a clear airway and that the tracheotomized patient will have a temporary loss of voice. Place a pencil and paper on the bedside table so he will know that a means of communication has been provided for him. Leave a tap bell always within his reach; the sound of the bell attracts attention as a substitute voice and is usually more reassuring to the patient than dependence on a signal light.

(2) *Provision of warmth and humidity.* For the first few postoperative days and for longer periods when required, keep the patient in a room where the temperature can be maintained at about 80 degress F. (warmer than usual ward temperature). Use a steam vaporizer or other humidifying apparatus constantly to moisten the air. These two measures help to reduce the tracheal irritation that results when inspired air has bypassed the natural warming and humidifying nasopharyngeal passages.

(3) *Preparation of patient unit for postoperative care.* The equipment listed below should be available at the bedside. Because of the number of items required, it is advisable to provide a mobile table or an additional bedside cabinet within the unit.

EQUIPMENT

Suction and pressure apparatus (mobile, portable, or wall unit)
Y-tube connector, for catheter
Sterile suction catheters (size 14 or 16 for adult)

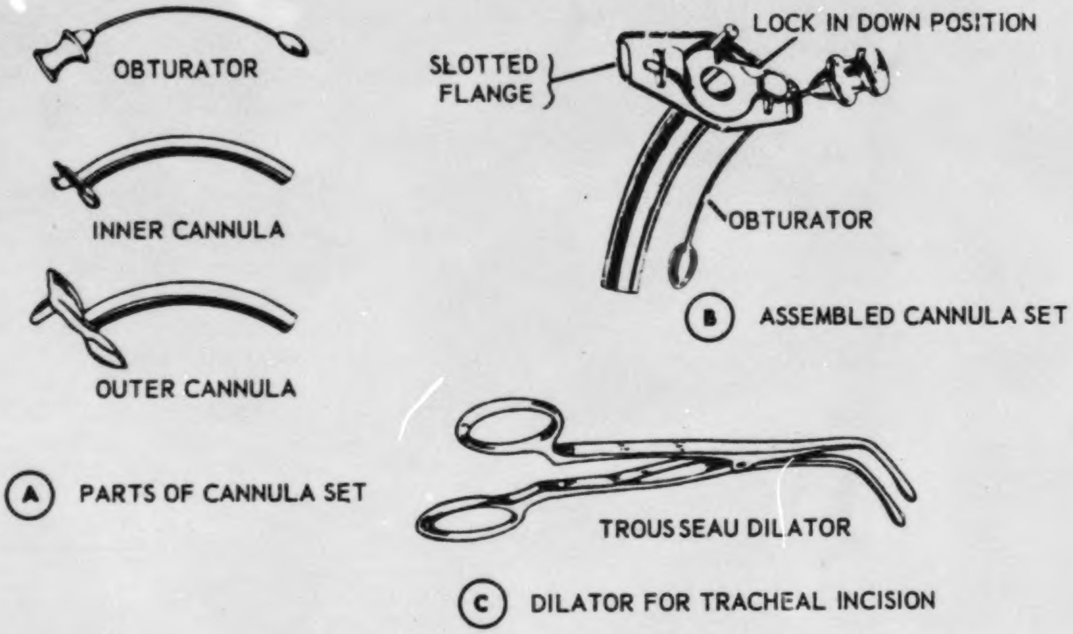


Figure 5-84. Component parts of tracheal cannula set.

Tracheotomy dilator, sterile (Trousseau dilator or Kelly forceps)
Tracheotomy cannula set (duplicate of set in use)
Sterile gloves (plastic, disposable), package
Sterile medicine glass and medicine dropper (or sterile 2 ml. syringe)
Sterile saline, flask
Sterile dressing set: scissors, thumb and Kelly forceps, gauze, 4 x 4 inch or other approved dressings
Sterile gauze, 2 x 2 inch, package
Sterile towels, package
Sterile water, flask
Oxygen supply with humidifier
Steam vaporizer or jet vapor humidifier
Cotton twill tape, roll
Bandage scissors
Basin, emesis
Hydrogen peroxide (or commercial surgical cleaner such as Hemosol)
Pipe cleaners or test tube brush
Pencil and paper
Tap bell
Adhesive tape, roll
Transfer forceps in container
Foil-wrapped germicide wipes (for hand cleansing)

CARE OF THE TRACHEOTOMY

Precautions

1. *Aseptic technique.* Apply basic principles of aseptic technique in caring for the incision and the airway. The tracheotomy wound is easily infected and tracheobronchitis and other respiratory tract infections such as bronchopneumonia can result from poor technique. Although strict surgical asepsis is difficult to maintain because of the nature of the wound and the secretions which are present, the following measures are important:

a. Use separate catheters for nasopharyngeal and tracheotomy suctioning.

b. Use separate flasks of sterile water for clearing the separate catheters. Clearly mark each flask "Nasal Catheter" and "Tracheal Catheter."

c. When possible, replace the used tracheal catheter with a sterile one for each aspiration. When this is not possible, clear the used tracheal catheter in water and place between sterile towel folds. The medical officer may recommend that the catheter be kept immersed in a mild, aqueous, germicide solution such as benzalkonium chloride (Zephiran) of a prescribed dilution.

d. Wear a new plastic, disposable glove on the hand used for manipulating the tracheal catheter. Discard the glove after each use. This measure is particularly helpful when handwashing at the bedside is not possible.

e. Keep the dressing clean and dry. NOTE: Initially, there may be two dressings. One is a gauze or surgical plastic-film dressing on the sutured incision area above the cannula; this dressing is changed only by the medical officer and is omitted when the sutured area heals. A second, the "tube dressing," should be changed as often as it becomes soiled by the secretions.

2. *Special observations.* Observe the patient constantly for such signs of respiratory obstruction as a bubbling sound during respiration, restlessness, cyanosis, or an increase in the pulse rate. In addition to these observations, watch for bleeding from the incision and in the aspirated secretions; for coughing; or for choking when swallowing saliva or oral fluids. (There may be some damage to the esophagus, with leakage of swallowed secretions into the trachea.) Any of the above signs must be reported immediately. Use care when shaving a male patient to prevent any hair from being aspirated—protect the tube opening with a moistened gauze square that will trap any small hairs but not obstruct the airway.

3. *Position and position changes.* Usually the patient is comfortable in a semirecumbent position. Assist and encourage him to change his position frequently and to turn from side to side at least q. 2 h. to promote aeration of the lungs and to aid drainage of secretions.

4. *Suctioning the tracheotomy tube.*
   a. Be gentle. Forceful introduction of the catheter and too strong suction pressure will damage the mucous membrane.
   b. Suction as often as needed to keep the tube clear. This may be every 5 to 10 minutes during the first few hours postoperatively.
   c. Limit each aspiration to about 5 seconds. The presence of the catheter in the tube reduces the airway.
   d. Flush the catheter before and after each aspiration. Check to see that the sterile water passes completely through the tubing to the suction bottle. Do not allow the bottle to become overly full.

Suctioning Technique

1. Test suction. Turn on suction apparatus and place tip of the catheter in the flask of sterile water labeled "Tracheal Catheter." Use the gloved hand to handle the catheter and the ungloved hand for other manipulations.

CAUTION

Check pressure gauge on apparatus and do not exceed prescribed pressure. As a general rule, the range for an adult will be 7 to 15 inches if gauge is calibrated in inches or 120 to 150 mm. if gage is calibrated in millimeters.

2. Wipe secretions from tube opening with sterile gauze.
3. With Y-valve open, insert the catheter about 5 inches into the tracheotomy tube.
4. Apply suction by placing finger over the free arm of the Y-valve (fig. 5-85) while gently rotating and withdrawing the catheter. If the catheter "grabs," remove the finger from the Y-valve.

CAUTION

Do not push the catheter up and down.
Do not pinch the tubing.

5. Flush the catheter on withdrawal.
6. Wipe secretions around tube opening after suctioning is completed.

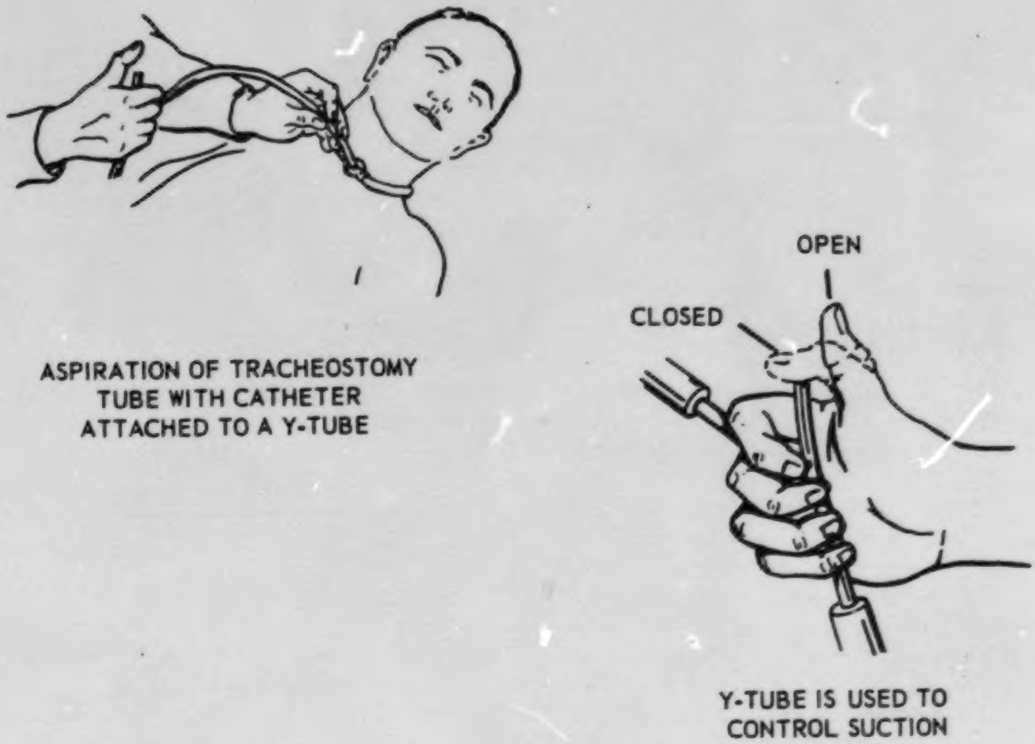
Care of Tracheotomy Inner Tube

The outer tube is removed and changed only by the physician. The inner tube is removed and cleaned by the medical specialist as often as necessary until the secretions subside; then it is cleaned at least twice daily.

1. Release inner tube by holding outer tube in place with index finger of one hand while turning lock at the top of the outer tube with the other hand.
2. Hold outer tube in place and remove inner tube, using outward and downward movement in conformity with the curve. Handle the inner tube carefully to prevent any dents.
3. Place inner tube in basin containing cleaner solution. (If hydrogen peroxide is used, use half and half with water; if a surgical cleaner is used, follow directions on container.)
4. Soak for a few minutes to loosen mucus and other adherent secretions.
5. Using pipe cleaners or the test tube brush, cleanse the inner tube of the loosened secretions. Repeat mechanical cleaning until the tube is clean.

NOTE

Never use cotton-tipped applicators —the tip can be dislodged and ob-


ASPIRATION OF TRACHEOSTOMY TUBE WITH CATHETER ATTACHED TO A Y-TUBE

Y-TUBE IS USED TO CONTROL SUCTION

Figure 5–85. Y-valve suction technique.

struct the tube; gauze squares that ravel may leave a thread or particle of gauze within the tube and are also potentially hazardous; a nonraveling gauze bandage strip may be used if pipe cleaners or test tube brush are not available.

6. Rinse the cleaned tube by pouring sterile water through and over it. (An accepted alternate: rinse the tube under a sink faucet, using cool running water.) Drain and dry with a sterile towel.
7. When so ordered, sanitize inner tube by boiling for 10 minutes, using a small instrument sanitizer—not the utensil sanitizer.
8. Aspirate the outer tube before replacing the inner tube.
9. Lock the replaced inner tube in position.

Assisting With Change of Outer Tube

1. Assist the medical officer as needed.
2. At the bedside, have the dilator (or Kelly forceps) available for holding open the incision into the trachea if necessary; the replacement tube set with tapes attached. (Tapes are customarily placed on the tube in CMS before the set is autoclaved.)
3. When the new tube set has been inserted by the doctor, tape the new obturator to the head of the bed.
4. Return the previously used set, complete with its obturator, to CMS.

To Change the Tube Dressing

1. Use aseptic technique.
2. Change the dressing as often as necessary. (The initial dressing is usually done by the medical officer.)
3. Support the outer tube shield while removing the gauze dressing to avoid displacement of the tube. If the dressing is stuck to the skin, moisten it with sterile saline before removing it.
4. Cleanse the skin around the tube, using prescribed skin cleansing solution or sterile saline. Report any signs of inflammation and any evidence of leakage of oral fluids or foods about the tube opening.
5. Cut a slit in a 4- x 4-inch gauze square or a nonadherent absorbent strip, halfway through. Be sure to put tape over the cut edges of the gauze to prevent a small piece of thread from entering the air passage.

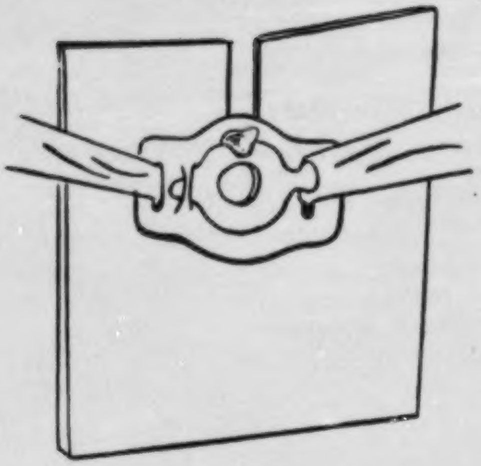


Figure 5–86. Tube dressing.

6. Using forceps, pull the slit dressing gently under the outer tube shield. Place the slit toward the chin. The uncut portion is below the tube to absorb secretions (fig. 5–86).
7. Check to make sure the dressing is secured underneath the shield. It must not slip out or occlude the airway. A strip of adhesive may be used on the upper edges to hold it in place p.r.n.
8. Check outer tube tape straps and replace them if soiled. While changing straps, ask the patient or an assistant to hold the outer tube in place until the straps are retied, as a cough could dislodge the unsecured outer tube. To replace tape ties—
   a. Cut two 16-inch lengths of tape, using bandage scissors.
   b. Cut a horizontal slit about 1 inch from one end of each tape.
   c. Thread the slit end through side opening of the outer tube and draw the opposite end through the slit.
   d. Tie tapes in a square knot at the side of the neck. Check to insure that they are tight enough to retain the tube but with no pressure.

Providing Humidity for the Tracheotomized Patient

Use one or more of the following measures, as prescribed by the medical officer, to moisten, warm, and filter the inhaled air. Mucus dries and forms plugs when the respiratory tract becomes dry; this dried mucus is hazardous and must be prevented from forming.

1. Place a 4- x 8-inch plain gauze compress to form a bib over a strip of tape, which is then tied around the patient's neck. Be sure to tie the bib tape in a bow on the side of the neck opposite to the square knot tape tie which secures the outer tube. Keep this bib, moistened with saline, over the tube opening.
2. Using a 2 ml. syringe or medicine dropper, instill 3 or 4 drops of sterile saline into the tracheotomy tube before suctioning. This instillation helps thin secretions for easier aspiration.
3. Administer nebulized mist, directed into the tracheotomy tube, by a nebulizer unit under air or oxygen pressure. A special apparatus is used for this treatment, so local instructions for its operation should be followed.
4. Use a steam vaporizer, directing the tube outlet upward toward the tracheotomy tube. Keep the patient from becoming damp or chilled from the steam, as chilling is conducive to respiratory infection. Protect the patient from drafts. Keep the windows and door in the room closed in order to help concentrate moisture from the steam.

Providing Oxygen Therapy

There are several methods of introducing oxygen into the tracheotomy tube. Four of these methods are listed below.

NOTE

> Whatever method is used the oxygen must be humidified, since oxygen is drying and will cause irritation. Administer at the rate prescribed by the doctor.

1. Use a commercial tracheotomy-oxygen device when it is available. This is a transparent plastic mask which fits over the tube.
2. Attach a small funnel to the oxygen tubing and place the funnel over the tube.
3. Use a bent-needle technique. Clip off the sharp bevel end of a 15-gage IV needle and bend the needle about halfway along the shaft. Attach the needle hub to the oxygen tubing. Insert the distal end of the needle into the tracheotomy tube, anchoring it with adhesive (fig. 5–87 Ⓐ).
4. Insert an oxygen nasal catheter about 1 inch into the tracheotomy tube, anchoring it with adhesive (fig. 5–87 Ⓑ). The catheter tends to obstruct the tube, and this method is, therefore, the least desirable of the methods to be used.

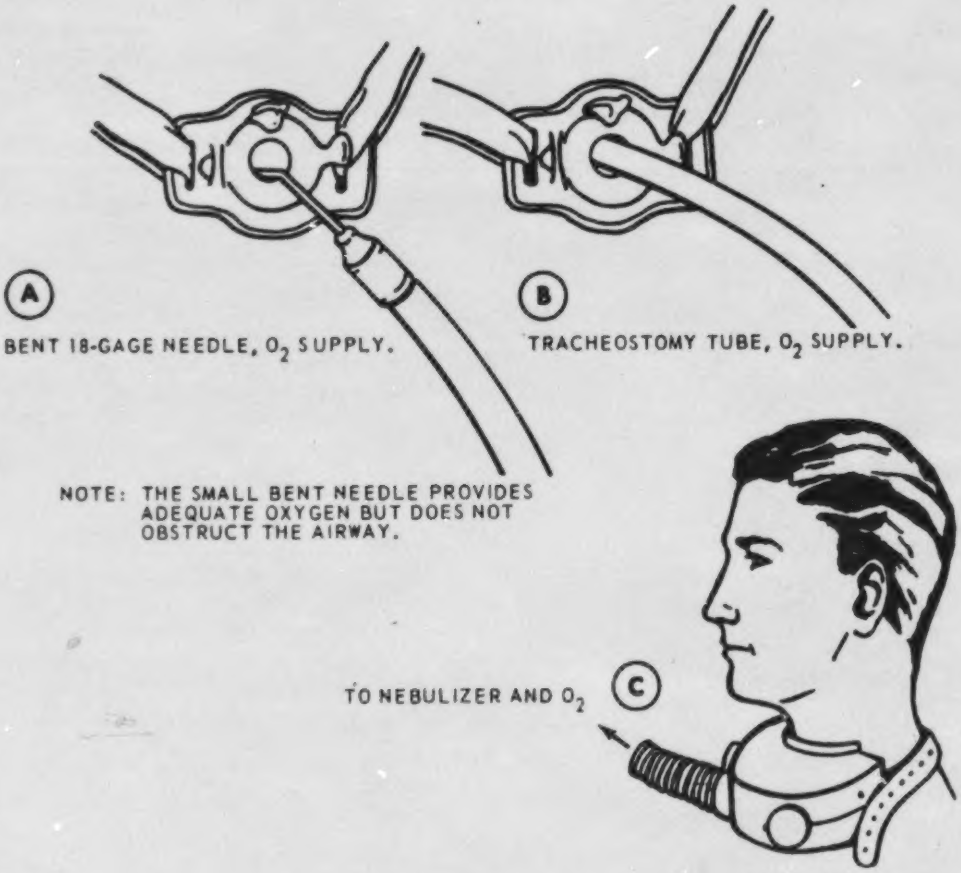

A
BENT 18-GAGE NEEDLE, O2 SUPPLY.
B
TRACHEOSTOMY TUBE, O2 SUPPLY.
NOTE: THE SMALL BENT NEEDLE PROVIDES ADEQUATE OXYGEN BUT DOES NOT OBSTRUCT THE AIRWAY.
TO NEBULIZER AND O2
C

Figure 5-87. Tracheotomy tube, administration of oxygen.

Assisting With Decannulation of Tracheotomy Tube

Decannulation (extubation) refers to the gradual elimination of the tube opening to permit the patient to return to normal breathing through his nasopharyngeal passage. The doctor orders the type of tube obstruction to be used and the interval and length of time it is to be left in place. Small corks or rubber stoppers, with wedge-cuts of varying sizes, are usually used. Following removal of the tube, the skin edges are approximated to permit healing of the incision. During the decannulation process—

1. Continue close observation for any signs of respiratory distress.
2. Be particularly observant of tolerance of the closure when the patient is asleep. Before the tube is removed, the patient should be able to breathe normally, with tube completely closed off, day and night.

5-111. Thoracentesis

Thoracentesis (chest tap) is the surgical puncture of the chest wall, to withdraw fluid or air from the pleural cavity for diagnostic and therapeutic purposes. A thoracotomy needle is inserted by the doctor through the intercostal (between ribs) area into the pleural cavity. Suction is then applied by syringe to aspirate the accumulated fluid or air. The procedure is usually done at the patient's bedside.

EQUIPMENT

Thoracentesis tray, sterile, from CMS
Drainage bottle, calibrated from CMS
Gloves, sterile
Compresses, 4- by 4-inch, sterile
Skin germicide, as prescribed
Local anesthetic, as prescribed
Emergency drug stimulant tray
Alcohol sponge container
Transfer forceps

Emesis basin
Tape, adhesive
Specimen labels
Water glass, empty (for specimen tubes)
Mobile table or Mayo stand

PREPARATION FOR THE PROCEDURE

1. Check Clinical Record for signed SF 522 (Authorization for Administration of Anesthesia and for Performance of Operations and Other Procedures).
2. Prepare the patient and reassure him with appropriate explanations. Assure him that the doctor and you, as assistant, will help him to maintain the required position and to avoid moving and coughing during the procedure.
3. Take and record TPR and BP.
4. Screen the patient. Remove pajama jacket to expose chest. The site of the puncture will depend upon the location of the fluid or air which is to be aspirated.
5. Position the patient as directed by the medical officer. The position may be either one of the following:
   a. Seated on the side of the bed facing away from the operator, with feet supported on a chair and the head and arms resting on an overbed table padded with pillows. The arms are elevated slightly to widen the intercostal spaces.
   b. Place in a semirecumbent position, facing away from the operator, resting on the nonaffected side, with the head of the bed elevated about 45 degrees. A pillow is placed under the chest to widen the intercostal spaces. The arm of the affected side is placed above the head to elevate the ribs, thereby making the insertion of the needle easier.

ASSISTING WITH THORACENTESIS PROCEDURE

1. Place thoracentesis tray on instrument table. Open sterile wrapper cover to provide a sterile field.
2. Place other supplies on adjacent bedside stand or overbed table. Open glove wrapper.
3. Pour germicide solution as required—this may be over a gauze sponge the doctor holds over the emesis basin, or into a sterile container on the tray.
4. Assist with handling of local anesthetic vial. Hold vial with label uppermost so that the medical officer can personally check the label before withdrawing any of the solution. Cleanse stopper with alcohol sponge. Invert vial and hold firmly while the doctor with gloved hands withdraws the required solution.
5. Assist as directed with securing sterile drapes.
6. As instructed by the doctor, support and help patient to avoid moving and coughing while the thoracentesis needle is introduced.
7. Assist as directed with collection of specimens as the doctor manipulates the syringe, the stop cock, and drainage tubing. Use transfer forceps in removing specimen tubes from sterile field. Use care not to contaminate the end of the tubing, the cap, and open end of the specimen tubes. Cap the tubes and place them upright in a clean glass provided for this purpose. Label each tube as directed by the doctor.
8. If drainage of a large amount of accumulated fluid is necessary, assist the doctor by placing the free end of the tubing in the drainage bottle.
9. Watch the patient's color; check pulse and respiration. Report any sudden change stat. as this may indicate damage to the visceral pleura from a nick or puncture by the needle.
10. Assist with application of dressing.
11. Position patient comfortably (usually Fowler's position).
12. Remove equipment from bedside to utility room. Return emergency tray to proper place.
13. Complete entries on appropriate laboratory request forms (SF 514–M, Miscellaneous) as directed.
14. Send properly labeled specimens with completed request forms to laboratory immediately.
15. Measure and record amount of fluid withdrawn and discard this fluid in hopper or utility room unless directed otherwise.
16. Care for equipment properly—discard disposables, place all linen in hamper, and return appropriate items to CMS.
17. Continue to observe patient for respiratory difficulty: any blood in sputum, persistent cough, or dyspnea. Take and record vital signs q. 4 h., or as ordered.
18. Enter this information on Nursing Notes: date and time, procedure, by whom performed, amount and type of fluid withdrawn, patient's reactions, and specimens sent to laboratory.

5–112. Underwater-Seal Chest Drainage

Underwater-seal chest drainage is a closed (airtight) system for drainage of air and fluid from the chest cavity. It is a postoperative treatment measure following chest surgery and may also be used as an essential part of the initial medical management, under field medical conditions, of a patient with an open chest wound (if the problem of immediate transportation for evacuation is not involved). The care and observation of the underwater-seal drainage apparatus is an important nursing responsibility in addition to all other patient care measures during the immediate and early phases of postoperative care.

a. Explanation of the Procedure. The underwater-seal system is established by connecting a catheter which has been placed in the patient's pleural cavity to drainage tubing which drains underwater in a sealed drainage bottle. As the patient exhales, air and fluid in the pleural cavity are pushed through the catheter and drainage tubing. By keeping the end of the drainage tubing under water, air is prevented from re-entering the tube; by keeping the drainage bottle at floor level, fluid is prevented from siphoning back. As air and fluid are drained and prevented from reentering the pleural cavity pressure on the lungs is relieved, and re-expansion of a collapsed lung is facilitated.

CAUTION

The catheter is clamped off by the medical officer at the time of its initial placement, and the catheter remains clamped until—

(1) The water-seal setup has been checked by the medical officer.

(2) The chest catheter connection to the drainage tubing has been checked by the medical officer.

(3) All connections are determined to be airtight.

b. Water-Seal Methods Used. The surgeon will specify the drainage setup he prefers to use. It is advisable to have CMS personnel obtain the required component parts, preassemble them to insure precise fitting, and process them to insure sterility. This type of preparation minimizes handling at point of use and promotes maintenance of asepsis.

(1) *Drainage without suction (1-bottle method).* Drainage without suction assistance is usually accomplished by means of a single underwater-seal bottle setup (fig. 5–88 Ⓐ). With this setup, the tube leading to the patient's catheter is connected to the long glass tube. The end of the long glass tube is submerged for a measured distance under sterile water. The long glass tube is the waterseal. The short glass tube is the air vent, through which air escapes to the atmosphere.

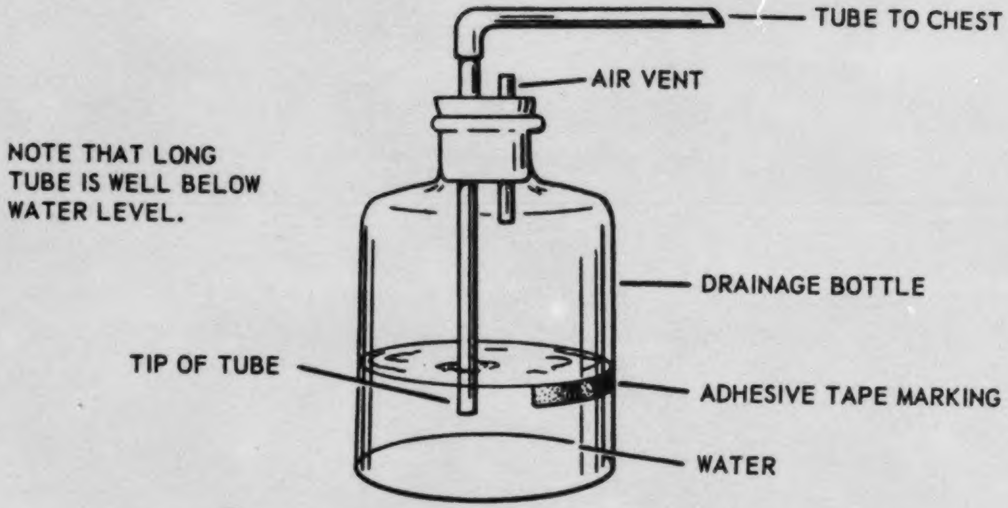
(2) *Drainage without suction (2-bottle method).* Drainage without suction using a 2-bottle method is illustrated in fig. 5–88 Ⓑ. This setup is used to prevent chest fluid from draining into the underwater-seal bottle. An airtight seal between the two bottles allows fluid to accumulate in the trap bottle (bottle 1) while air passes into the water-seal bottle (bottle 2) and escapes through the air vent. There is less hazard of possible ascending bacterial infection when the tubing leading to the patient's chest is not directly connected to the underwater seal. However, there are increased hazards from loose or improperly made connections to the water seal; this could lead to collapse of the lung.

(3) *Drainage with suction assistance (thermotic pump).* Drainage with suction assistance is used when water-seal drainage alone does not eliminate free air from the pleural cavity in sufficient quantities to permit lung expansion. Suction is usually provided by means of the thermotic pump (GOMCO, fig. 5–89) or an Emerson postoperative pump (fig. 5–90). This is a nonstandard item that is, however, used extensively in AMEDD hospitals. The thermotic thoracic pump is designed to provide automatic suction at a predetermined suction pressure. The doctor determines the amount of suction to be used by: (a) adjusting the water level in the manometer (bubble tube), and (b) by ordering the apparatus switch set on high or low. (Refer to the manufacturer's instruction manual and the local procedure manual for operating instructions.)

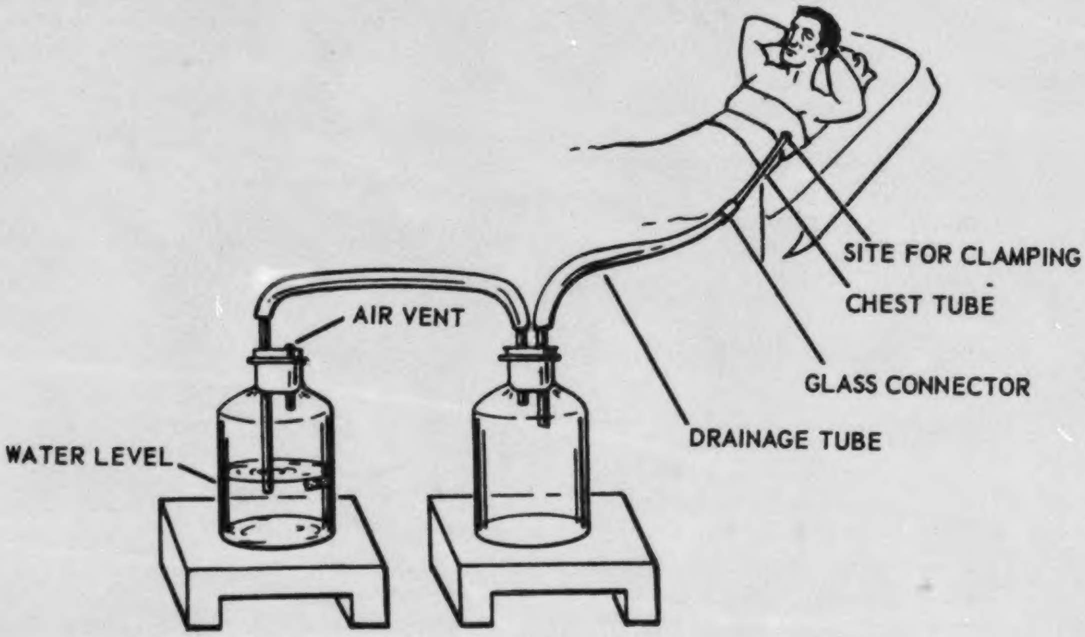
5–113. Underwater-Seal Drainage (One-Bottle Method)

(fig. 5–88 Ⓐ)

The underwater-seal drainage system using the one-bottle method is the system most commonly used when suction assistance is not required. The component parts, assembled in accordance with the instructions of the medical officer, are obtained from CMS. All adjustments and connection made at the bedside are made by the medical officer or are made by the nurse or medical specialist under the direction and supervision of the


TUBE TO CHEST
AIR VENT
NOTE THAT LONG TUBE IS WELL BELOW WATER LEVEL.
DRAINAGE BOTTLE
TIP OF TUBE
ADHESIVE TAPE MARKING
WATER

Ⓐ WATER-SEAL DRAINAGE APPARATUS


SITE FOR CLAMPING
AIR VENT
CHEST TUBE
GLASS CONNECTOR
DRAINAGE TUBE
WATER LEVEL

Ⓑ THORACIC WATER-SEALED DRAINAGE BY GRAVITY.

Figure 5-88. Water-seal chest drainage without suction.

medical officer. Aseptic technique must be maintained in preparing and handling the equipment.

EQUIPMENT

Drainage bottle set, sterile
Drainage tubing, with connector, sterile
Clamps, Kelly, rubber-shod, 2
Adhesive tape, 3-inch roll
Drainage bottle floor holder
Flask of sterile water
Pencil or marking pen
Safety pins

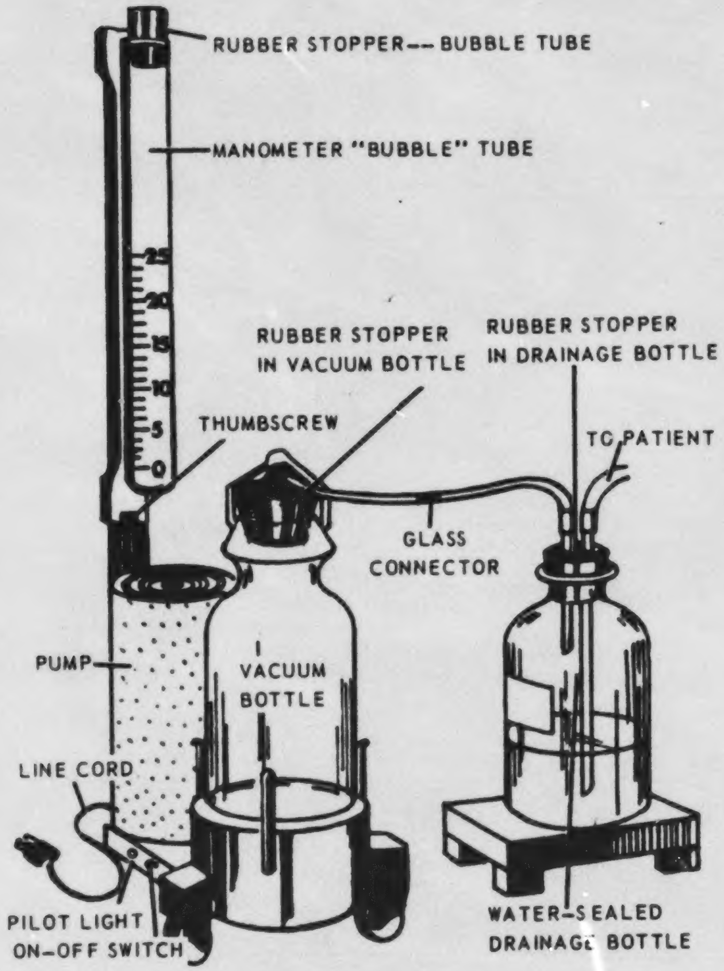

RUBBER STOPPER—BUBBLE TUBE
MANOMETER "BUBBLE" TUBE
25
20
15
10
5
0
THUMBSCREW
RUBBER STOPPER IN VACUUM BOTTLE
RUBBER STOPPER IN DRAINAGE BOTTLE
TO PATIENT
GLASS CONNECTOR
PUMP
VACUUM BOTTLE
LINE CORD
PILOT LIGHT
ON-OFF SWITCH
WATER-SEALED DRAINAGE BOTTLE

Figure 5-89. Water-seal drainage (GOMCO suction pump).

Preparation of Equipment at the Bedside

1. Make sure the long glass tube extends into the water to the depth specified by the medical officer. The initial depth is usually 2 ml. (approximately one inch), or just far enough for the end to remain submerged when water fluctuates in the glass tube as the patient breathes or coughs. The farther the tube extends into the water, the greater the intrapleural pressure must be to expel air and fluid into the drainage bottle.

NOTE

When received from CMS, the set is usually preassembled, with the stopper inserted and covered by a sterile paper cap. If sterile water has been already placed in the bottle, the amount in ml. or cc. should be indicated on the bottle so that the total amount of subsequent fluid drainage can be measured.

2. Tape the stopper securely to the neck of the bottle.
3. Place a strip of tape vertically on the bottle, from bottom to top. With pencil, mark on the tape the original fluid level in the bottle. Subsequent readings at the periodic intervals ordered by the doctor will also be marked on this tape strip.
4. Print "DO NOT LIFT" on a second strip of tape and stick this on the shoulder of the bottle so that it is visible from above.
5. Fold a strip of 3-inch adhesive to make a tab. Stick this tab on the head of the bedframe and secure the rubber-shod Kelly clamps to the tab

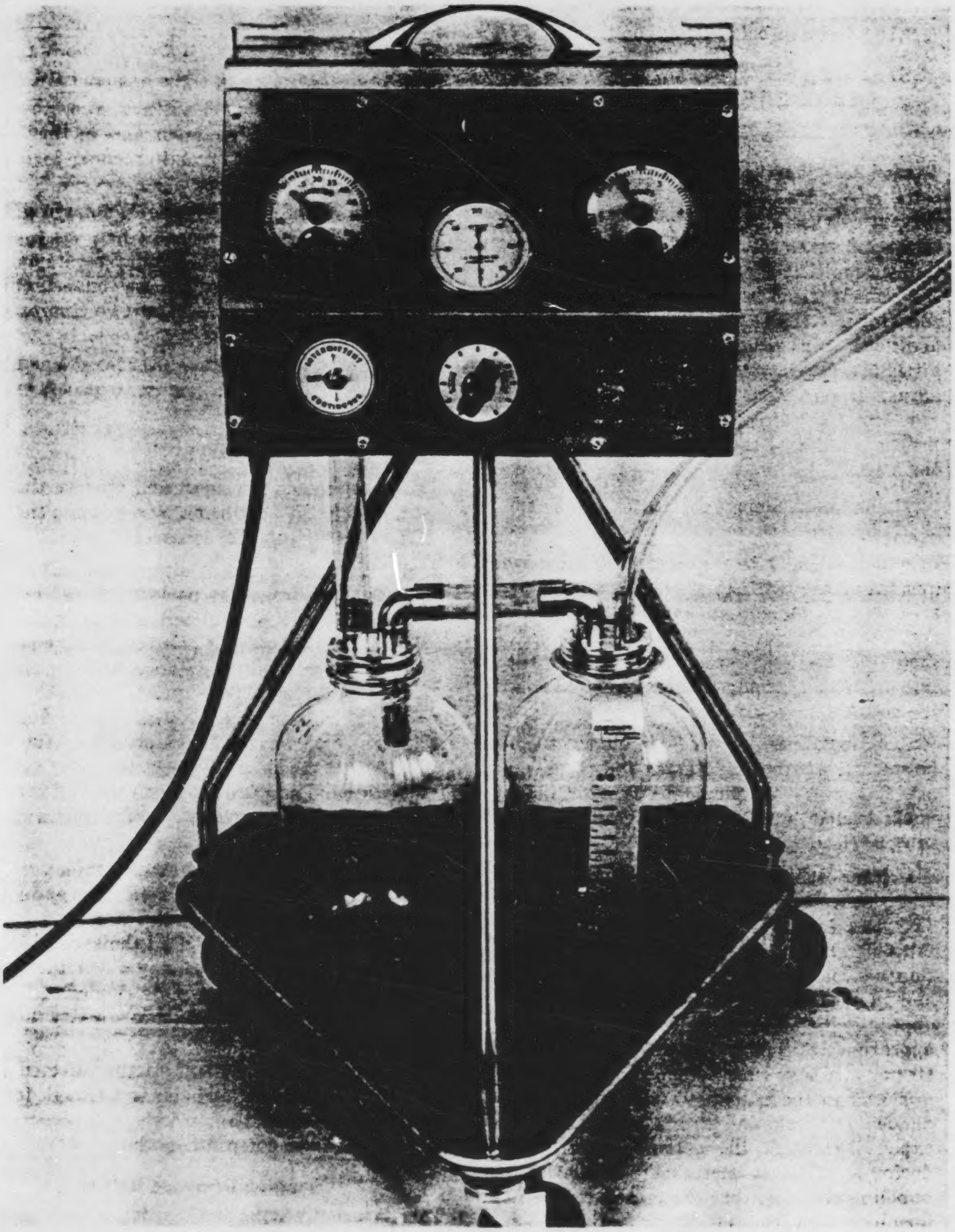


Figure 5-90. Emerson postoperative pump.

for immediate availability in clamping the patient's chest catheter in case of emergency.

6. Place the drainage bottle holder on the floor.

ESTABLISHMENT OF DRAINAGE FROM THE PATIENT

NOTE

The medical officer connects the patient's catheter and the drainage tubing, checks the entire system to verify all connections, and tapes all catheter connections to insure an airtight system. He removes the clamps from the chest tube after checking all connections. These clamps are never released until the system is airtight and ready to function. Then he adjusts the drainage tubing to eliminate any loops or kinks and specifies the proper location of the drainage bottle on the floor.

After this has been done, your duties are as follows:

1. Fasten the holder to the floor with adhesive and fasten the bottle to the holder with adhesive. (If no holder is available, fasten the bottle to the floor with adhesive.) This securing of the bottle is a precaution to avoid tilting, lifting, or inadvertent kicking over of the bottle.
2. Watch for fluid drainage in the connector tube between the patient's catheter and the drainage tubing. There should be free drainage, unobstructed by kinks, compression of the tube, or clotting of the fluid.
3. Watch for oscillation (fluctuation) in the long, glass, water-seal tube in the drainage bottle. The fluid level in this tube should rise and fall with the patient's inhalation and exhalation; on inhalation the fluid rises in the tube and on exhalation the fluid falls, and bubbles appear in the bottle fluid. This oscillation and appearance of bubbles ceases when the catheter or drainage tube becomes blocked; there is a leak in the system; or the lung has expanded, and fluid and air are no longer being expelled through the catheter. Notify the doctor or nurse at once should oscillation or bubbling cease, so that the reason can be determined and the necessary action taken. Permissible action for you to take without further instruction from the nurse or doctor is to check to see that the catheter or drainage tubing is not kinked or pinched off in any way and that all connections are apparently airtight.
4. Observe the patient for signs of dyspnea, cyanosis, rapid pulse, chest pain, and profuse perspiration. Report signs immediately.
5. Instruct all personnel, visitors, and other patients regarding the importance of the drainage bottle. It must remain at floor level and in its original location.
6. If any part of the system is impaired, immediately clamp the chest catheter as close to the chest wall as possible. Impairment includes such things as air leak, loose connection and raised drainage bottle. Use two clamps, one distal to the other.
7. Take fluid level readings as ordered, and mark the level, date, and hour with pencil on the vertical tape strip.

NOTE

It is necessary to kneel and observe the fluid level at floor level. Never clamp the tube and lift the bottle unnecessarily.

8. Continue all required postoperative care measures. Encourage the patient to deep-breathe and to cough as ordered and as instructed. The chest catheter is painful, and the patient needs maximum assistance and encouragement. Sit the patient upright with the aid of a pull-rope and have him lean forward slightly during the cough procedure for more effective drainage. Support the chest incision with hand and towel pressure, using care not to compress or otherwise interfere with the catheter.
9. Check fastening of drainage tubing to the foundation bedsheet to avoid loops and kinks. Support the tubing by pinching up and pinning a bridge or trough in the sheet, with no compression on the tubing from the safety pin. Be sure that the glass connector is visible at all times to observe gravity flow of drainage.
10. In turning the patient to the affected side, support the chest catheter in a trough formed by two folded bath towels to prevent body weight from compressing the catheter.

Changing Drainage Bottles

This is usually done by the doctor but may be done by the medical specialist when so ordered by the doctor.

1. Clamp the chest tube, using 2 clamps, before disconnecting any of the drainage apparatus.

2. Have a sterile bottle set up in readiness for immediate exchange.
3. Maintain sterility of connections.
4. Disconnect drainage tubing from the long glass insert in the used-bottle stopper.
5. Reconnect drainage tubing to the long glass insert in new bottle stopper.
6. Tape connection to insure airtight seal.
7. Check water level to insure that end of glass tube is submerged the required distance. Check to see that measured amount of water is recorded on the tape strip.
8. Tape stopper to bottle neck.
9. Release chest catheter clamps after insuring all connections are airtight. Secure clamps to head of bed.
10. Observe drainage in glass connector from chest catheter immediately after releasing clamps. It should be re-established without delay. Watch for fluctuation in the long glass tube.

Care of Used Equipment

1. Measure and record amount, color, and time interval of drainage. Subtract measured water from total to obtain fluid drainage total.
2. Remove all tape from the used-bottle stopper, glass tubing, and bottle surface. Use acetone or ether to remove sticky residue. Handle carefully to avoid breakage. Do not attempt to remove glass inserts from the bottle stopper.
3. Rinse bottle, stopper, and glass inserts in cold running water. Return all parts to CMS, protecting glass inserts by wrapping in towels to prevent breakage.

Recording

1. Enter in the Clinical Record, on DD Form 640, (Nursing Notes), the following information:
   a. Date and time of change of drainage bottle.
   b. Amount, color, and type of fluid (for example: sero-sanguinous (pinkish or light red), dark red, yellowish).
   c. Person who changed drainage bottle.
   d. Statement as to whether or not specimen was sent to laboratory.
2. Enter on DD Form 792 (Nursing Service—Twenty-Four Hour Patient Intake and Output Worksheet) the amount of measured drainage. This amount is the difference between the initial measured water and the amount in the bottle when the bottle is replaced.

Section XI. NURSING CARE OF THE ORTHOPEDIC PATIENT

5–114. Introduction

Orthopedics is the medical specialty that includes the investigation, preservation, restoration, and development of the form and function of the limbs, spine, and associated structures by medical, surgical, and physical means. The basis of orthopedic nursing is understanding and applying the principles of body mechanics (sec. III). While the application of these principles is a basic requirement in all nursing care, additional emphasis is needed when working with orthopedic patients. The challenge in caring for the orthopedic patient is in devising ways to carry out basic nursing care while understanding and working with orthopedic mechanical devices, such as splints, casts, traction devices, and turning frames, that are used in treating and aiding the healing process of bone fractures, joint disorders, muscle and nerve injuries, and other affections of the musculoskeletal system. Usually, the injured part and associated structures must be immobilized, while at the same time circulation must be maintained and muscles used to prevent atrophy. The average orthopedic patient is a long-term patient, whether undergoing treatment in the hospital or on an outpatient basis. Following a period of intensive treatment, he must undergo a long period of supervised convalescence to insure optimum recovery. He can be expected to resent the necessary restrictions imposed upon him and to become impatient or discouraged. Therefore, every patient must be taught and encouraged to become as self-reliant as possible, while at the same time he must understand the limits ordered by the doctor to insure healing and regaining of function.

5–115. Common Orthopedic Conditions

a. Under both peacetime and combat conditions, orthopedic patients account for a high percentage of occupied hospital beds and outpatient clinic visits. Usually the greatest number of patients will be under treatment for fractures due to trauma. The medical specialist is likely to encounter orthopedic conditions caused by—

(1) *Trauma.* Fractures, dislocations, sprains, and strains. In addition to injury to bones and joints, there are complicating factors of injury to

muscles, tendons, blood vessels and nerves, and often large open wounds are involved.

(2) *Disease.* Arthritis, osteomyelitis, neoplasms (both benign and malignant), and tuberculosis.

(3) *Congenital deformities.* Congenital dislocation of the hip and talipes (clubfoot). The medical specialist will usually encounter these conditions on the pediatric service (ch. 10).

(4) *Development defects.* Foot ailments such as flatfoot and bunions and spinal deformities due to abnormal or exaggerated spinal curvatures such as kyphosis and scoliosis.

(5) *Post-disease or post-trauma paralysis.* Residual paralysis from disease or from trauma of the extremities or trauma that damaged the spinal cord. Residual muscle paralysis from a disease such as poliomyelitis (infantile paralysis) may be treated surgically on the orthopedic service, or the orthopedic surgeon may refer the patient to the orthopedic brace shop. At other times, surgery and bracing will both be used. Other types of paralysis may be similarly treated. The medical specialist will find that, in AMEDD facilities, injury to the central nervous system is usually treated on the neurosurgical service; however, some conditions are also treated on the orthopedic service.

b. TM 8-231 gives additional information on these and other orthopedic conditions.

c. For emergency treatment of fractures, refer to FM 21-11 and chapter 8, this manual.

5-116. Healing of Fractures

a. When a bone breaks, there is always an injury to the periosteum (the membrane that covers the bone) and to the surrounding tissues. There is also hemorrhage about the ends of the fragments, and the space between the two fragments rapidly becomes filled with a blood clot. This blood clot is invaded by cells which form granulation tissue; this then forms a union of fibrous tissue known as a soft callus between the ends of the bone. Next, bone-forming cells begin growing in from the periosteum. (If the periosteum has been torn away or killed, these cells are not present.) They gradually form the soft callus into a hard callus, making a firm bony union between the broken ends of the bone. In treatment of fractures, the bones are brought into proper alinement and immobilized until X-ray shows that a hard callus has been formed.

b. Many conditions can interfere with the proper healing of a fracture; *for example—*

(1) *Poor blood supply.* If one of the parts of the broken bone is not supplied by blood, that part may die and union will not take place. This is prone to occur in the neck of the femur, the patella, the elbow end of the radius, and several other places where circulation is poor.

(2) *Poor immobilization.* If the fracture is not properly splinted and motion continually takes place at the site of fracture, the bony union will not take place.

(3) *Infection.* If the fracture site becomes and remains infected, union will not take place. There is a great danger of this occurring in open fractures because infection takes place through the open wound.

NOTE

Dressing technique on an orthopedic ward must be faultless to prevent wound and bone infection. In addition to strict asepsis for ALL patients, it is customary to place patients with infected wounds in a ward separate from one in which there are patients with clean wounds.

(4) *Interposition of soft parts.* If a piece of muscle or other tissue gets between the ends of the broken bone, bony union cannot take place.

(5) *Dietary deficiency.* If the diet of the patient does not include enough calcium or other minerals, new bone cannot be formed.

(6) *Pathological fractures.* These are fractures due to a disease process which causes a gradual weakening within the bone. Parathyroid disease (hyperparathyroidism), syphilis (when untreated or inadequately treated), bone tumors, and other diseases can weaken a bone so that only slight stress is needed to fracture it, and the disease of the bone may impede or prevent union.

5-117. General Nursing Care for All Orthopedic Patients

a. Skin Care. Besides basic hygiene measures, the orthopedic patient needs special skin care. Since he is often confined to his bed and in many cases is immobile because of a cast or traction, he is particularly susceptible to bed sores. Change the patient's position within permissible limits each 2 to 4 hours; give frequent alcohol (or skin lotion) rubs; and if rubber rings, sponges, or pads are used, use them cautiously, making sure that new areas of circumscribed pressure are not being created and that there is a redistribution of body weight with relief of pressure area. Remember skin care includes attention to hair (brushing and shampoos) and toe and finger nails. Always provide a clean, smooth, dry bed, with wrinkle-free foundation sheets and bed clothing. Use orthopedic pajamas which are generously proportioned, with seams held closed by snap fasteners for ease in putting on and removing over casted areas. Patients in traction do not wear pajamas over the particular area in traction.

b. Diet. At first the orthopedic patient may have little or no appetite. He must often be fed while flat on his back or with both hands and arms immobilized. He must not be hurried and his meals should be as pleasant and as much of a social occasion as can be managed. The diet is ordered by the doctor, but it is a nursing responsibility to do everything possible to insure the patient's acceptance of it.

c. Elimination. A special effort must be made to prevent constipation and urinary complications when a patient is immobilized. Diet, fluid intake, prescribed exercises, and prompt attention to the patient's request for a urinal or bedpan are all important preventive measures. Special attention must be paid to proper placement of the urinal and the bedpan while maintaining the patient in alinement. The patient must often be assisted in cleansing himself after elimination, as casts and other orthopedic devices must be protected from becoming wet and soiled. A patient on crutches or up in a wheelchair who is permitted weight bearing on one leg can often be self-sufficient in getting himself on and off a toilet if provision has been made for grab bars and wide doors on toilet cubicles and the patient has been shown how to transfer himself safely to and from the commode.

d. Maintaining the Patient's Morale. Because of his long hospitalization, his immobility, and his fear of deformity, he may become unduly depressed or discouraged. Your understanding and encouragement can do much to support his morale. Encourage him to do as much for himself as possible. Give him help willingly when he asks for it, and use each occasion as an opportunity to teach him to be more self-reliant. In fostering self-reliance, ward personnel must be extremely safety conscious. Floors should be kept clean, clear of all obstacles, and nonslippery. The patient's bedside unit should be arranged in as orderly a manner as possible but always so that it is safe and usable for the patient and personnel. Occupational therapists and physical therapists help the patient to restore and strengthen muscle function, and he may have therapeutic exercise and diversional equipment at his bedside. The recreational and social services of the American Red Cross are important elements also in his social and personal life. Nursing personnel must be aware of all the different activities that contribute to total care of the orthopedic patient.

5-118. Devices Used in Caring for the Orthopedic Patient

a. General. New orthopedic devices are constantly being put into use, but all of them are directed toward a two-fold aim: to provide support for the injured part until it heals and to prevent deformity and stiffness of the injured muscles and joints. Support for the injured part may be provided by bandages; adhesive strapping; splints, including plastic inflatable ones; or plaster casts applied externally. Support may also be applied internally to a bone by using pins or plates. To prevent stiffness, the patient must use the affected part as much as possible within the limits ordered by the doctor. Physical therapy is usually begun as soon as possible and may be continued for an extended period of time following the healing of the affected part. The patient often needs the support of braces, splints, or crutches for some time after he becomes ambulatory.

b. Basic Ward Equipment.

(1) *Orthopedic bed.* The basic orthopedic bed is the standard hospital bed with a firm, nonsagging mattress. A slatted orthopedic bedboard (fracture board), placed between the spring and a thin firm, hair (or foam rubber) mattress may be ordered by the medical officer to replace the usual hospital innerspring mattress. The slatted construction of the bedboard permits adjustment of the bed gatch and also permits rolling of the bedboard for storage. Longitudinal boards, placed so as to rest on the end rails of the bedframe (not on the springs), may also be used.

(2) *Overhead bedframe.* The Balkan-type frame is illustrated in figure 5-91. Upright poles are clamped to the four corners of the bedframe, and the overhead, head, and foot bars and clamps are then adjusted to accommodate any traction and suspension system required. Unless otherwise ordered, the Balkan frame is provided for all traction patients. Any adjustment of the frame is usually done by the doctor or orthopedic specialist (MOS 91H).

(3) *Trapeze.* The trapeze (fig. 5-91) is provided when the patient is permitted to lift himself

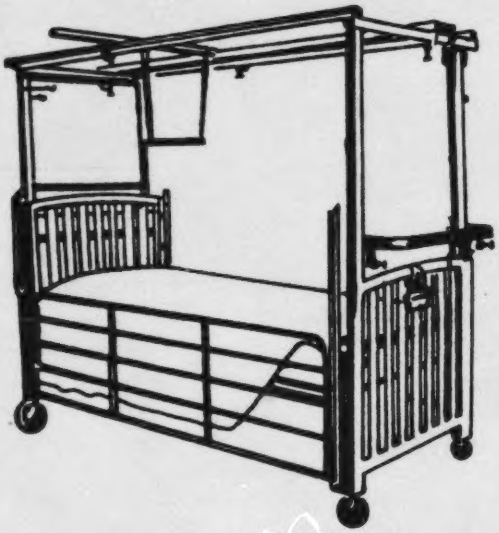


Figure 5-91. The orthopedic bed set up with Balkan frame.

in bed. When a trapeze is used, instruct the patient how to use it. Proper use protects the elbows and heels from pressure and from friction burns caused by the bedsheet; it also maintains body alinement. The patient should not drag the weight of his body on the bed nor twist his spine. He should:

(*a*) Grasp the bar firmly.

(*b*) Flex the knee of the unaffected leg and place the foot flat on the mattress.

(*c*) Push down on the bed with the foot and pull straight up on the trapeze.

(4) *Wheelchair*. Several special precautions must be observed when orthopedic patients are permitted to use a wheelchair (fig. 5-92).

- If a patient is to ambulate when out of bed, he is not allowed to use a wheelchair.
- If a patient is allowed to propel himself in the chair he must be cautioned not to use the chair as a racing vehicle. Young, energetic patients often are tempted to use their chairs in a manner hazardous to themselves and to everyone else.
- When any patient gets in or out, the chair must be well stabilized so that it will not roll when the patient shifts weight or changes position. A fall will injure the patient physically and will also damage his self-confidence and self-esteem. The braking device, if any, is set, and the wheelchair braced against a wall or stable piece of furniture, or someone holds the chair for the patient. The method of getting into and out of a chair will depend upon the type of chair and the patient's disability.
- Adjustable chair. A patient in a large, bulky body cast that does not permit any bending at waist or hip may be lifted into an adjustable chair that has been prepared with pillows to support him in a semirecumbent position. This move from bed to chair provides welcome diversion from prolonged confinement to bed. The chair itself must be in perfect mechanical condition and the back and leg rests must be securely locked, once the rests are adjusted to conform to the patient's needs.
- Folding chair. The folding wheelchair is most commonly used for a patient who can sit up-

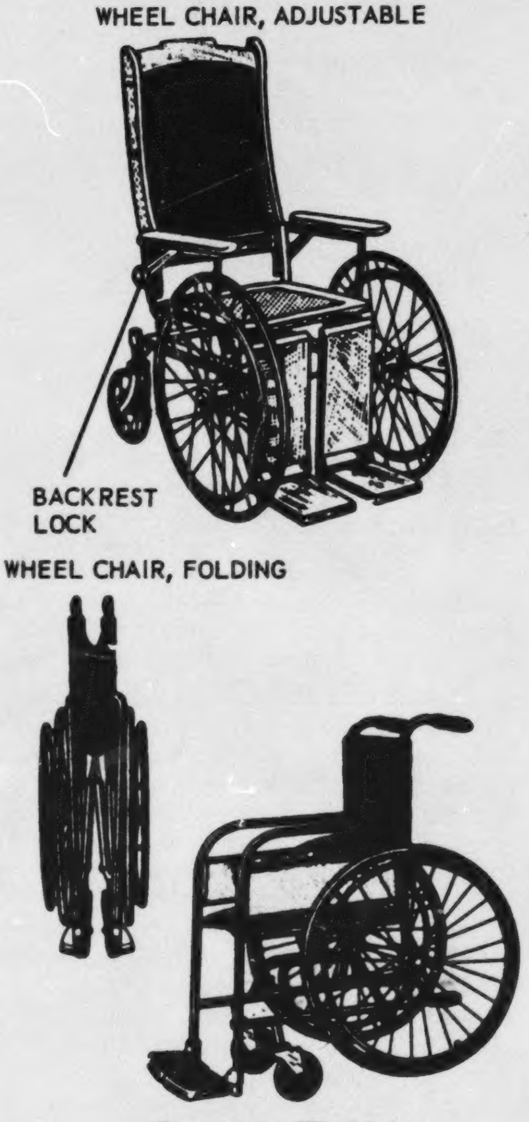


Figure 5-92. Wheelchairs.

right. If leg elevation is required, a board may be anchored under the seat cushion and pillow supports provided. In seating himself or getting out of the chair, the patient must be cautioned to fold back the footrests (if he attempts to stand on one, the chair will tip over); to support himself on the armrests as he lowers himself into the chair or pushes himself out of the chair; and in lifting himself from the chair, to place the leg on which weight bearing is permitted with the foot flat on the floor and slightly under the chair seat—he is then in position to push upright with his quadriceps (thigh) muscles and shoulder and arm muscles.

5-119. Assisting With Care of the Patient in a Cast

a. General. Casts are applied to maintain a part of the body in a fixed position. They are used in the treatment of fractures to immobilize and hold bone fragments in position for healing, to prevent movement in soft-tissue injuries, and to correct and maintain proper alinement in the treatment of deformities. The cast is usually applied by the medical officer and the orthopedic specialist, who works under the supervision and direction of the medical officer. In special situations, in the absence of an orthopedic specialist, the medical specialist may be required to assist the medical officer in the application of the cast; for example, in a dispensary, an outpatient may require application of a standard arm cast or a leg cast. Should this occasion arise, the medical specialist will follow the physician's orders; he will never attempt to apply or alter a cast except under the direct supervision of the physician. In preparation for this type of assistance, he should refer to TM 8-231. In addition, he should visit a hospital cast room and be oriented to basic cast equipment and cast application techniques by an experienced orthopedic specialist.

b. Care of the Patient in a Cast. It is a nursing responsibility to care for the patient while preserving the efficiency of the cast. (The efficiency of the cast is its ability to maintain the position for which it has been applied over the period of time necessary to accomplish the doctor's purpose.)

(1) Handle a wet cast carefully. A newly applied cast is set and firm when the patient leaves the cast room, but the cast is still damp. It requires 24 to 48 hours to become dry and hard.

(*a*) Prepare the bed to receive the patient. If the patient has been anesthetized, complete the foundation as for the postoperative bed.

(*b*) Provide plastic-protected pillows to support the cast along its entire length. Never permit the wet cast to rest directly on a flat, firm surface, because this will flatten the molded contours of the cast and cause pressure within the cast.

(*c*) Handle the damp cast by lifting and supporting it on a pillow or on the palms of the hands. Avoid using the fingers, as they will leave indentations which cause pressure within the cast.

(*d*) Never cover a damp cast. Leave it exposed to free air circulation. This is essential, as a drying cast generates heat within the plaster itself. In hot and humid weather the patient can suffer from excessive heat build-up and may need an electric fan directed toward the drying cast for improved air circulation and cooling.

(2) Observe an extremity encased in plaster for impairment of circulation.

(*a*) Inspect fingers and toes, and make sure all are visible.

(*b*) Check fingers and toes of inclosed extremity and compare them with the uninvolved extremity for numbness, coldness, swelling, and ability to move voluntarily.

(*c*) Use the blanching test. Compress the nail of the patient's thumb or the great toe of the limb in the cast with the fingers momentarily and then release the pressure. The nail should blanch (turn white) on pressure but the pink color should return immediately. Failure to blanch indicates impaired venous circulation and congestion of tissues; failure of the pink color to return immediately indicates impaired arterial circulation. In either case, report abnormal signs immediately, day or night. Do not wait. Permanent paralysis of a hand or foot can result from impaired circulation caused by cast pressure.

(3) Check for complaints of a burning sensation, numbness, tingling, pressure, or pain within the cast. Report the location and nature of the complaint.

(4) Elevate an extremity in a newly applied cast for the first 24 to 48 hours to prevent and relieve edema, which frequently develops soon after application of the cast. Elevation and ice bag application are often ordered. When a newly applied cast is elevated, it should be supported along its entire length, on an inclined plane, with distal joints higher than proximal joints—*for example*, hand higher than elbow, elbow higher than shoulder.

NOTE

If ice bags are ordered, suspend ice bags on either side, saddlebag fashion. Do not lay bags directly on the damp cast. Place ice bags in 6-inch wide stockinette sleeves and hang the sleeves on an IV pole so that the ice bags are in contact with the designated area of the cast.

(5) Turn the patient, while supporting the cast at the joints, to allow all parts of the cast to dry. Remove and replace pillowcases if damp. Note any signs of pressure of cast edges on skin. Arrange pillow supports to relieve pressure, as well as to maintain posture and alinement.

c. Finishing and Protecting Cast Edges

(1) Cast edges may have been trimmed and finished with a smooth edge at the time of application, or edges may be finished after the cast is completely dry. The smooth finished edge prevents crumbs of plaster from working loose and settling inside the cast or in the bed where they would cause pressure sores.

(*a*) Stockinette lining finish. Pull the free end of the stockinette lining out and fold it back smoothly over the edges of the cast. Tape the stockinette edge to the thoroughly dry cast.

(*b*) Adhesive petal finish. When there is not enough stockinette or other lining material to pull over the cast edge, use adhesive tape prepared as follows (fig. 5-93):

1. Cut 1-inch (or wider) adhesive in 12-inch strips.

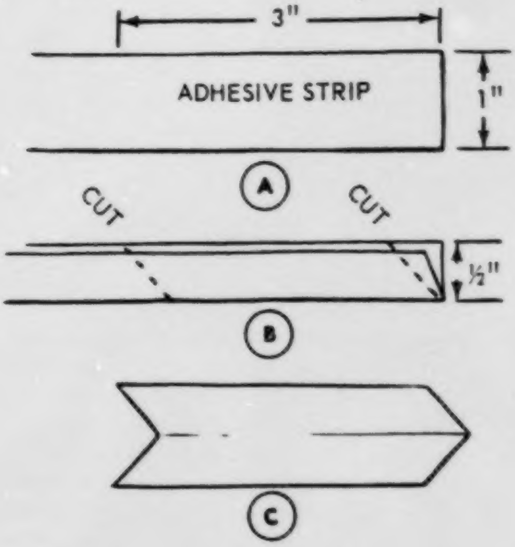


Figure 5-93. Petaling edges of cast.

2. Fold tape strips lengthwise, cloth sides together (sticky sides out).

3. At 3-inch intervals, cut pieces at a 45° angle to form petals.

4. Open each petal. Place the double point inside the cast. Overlap the petals smoothly, both inside and outside.

(2) The buttock and perineal edges of a hip spica cast and the top edge of a long leg cast should be protected with moisture-proof material such as plastic film to prevent soiling and moisture accumulation. Soiled cast lining and cast edges will cause skin irritation and a moldy, odorous, weakened cast. The adult male patient may require posterior protection only when using a bedpan, but the female patient and all children will require more complete protection.

(*a*) Cut strips of plastic in 4- to 6-inch widths. Fit overlapping strips smoothly under the cast and secure the free ends to the outside.

(*b*) Replace soiled strips with clean, dry strips. Pull out the strips at least once daily and check the lining and the cast beneath the waterproofing for soiling and moisture accumulation.

(*c*) Never apply waterproofing strips to a damp lining or plaster area. Air-dry the cast and lining before reapplying plastic.

d. Observation and Care of Skin.

(1) Look at all edges of the cast and all skin areas where the cast edges may cause pressure. Change the position of the patient and elevate and support the cast to relieve pressure. If there are signs of edema or circulatory impairment, notify the nurse or doctor immediately.

(2) Slip fingers under cast edges as far as it is possible to reach to detect any plaster crumbs or other foreign material that may have worked under the cast edge. Move the skin gently back and forth with fingertips to stimulate circulation.

(3) Lean down and smell cast edges, cast areas covering bony prominences and joints, and cast area covering wounds to detect odors indicating tissue damage. A musty or moldy odor at the surface of the cast may be the first indication that necrosis from pressure has developed beneath the cast.

(4) Check all other uncasted skin areas to detect signs of pressure. Be alert to any tendency of the patient to use heels and elbows to brace or push himself up in bed. Remind him to use the trapeze properly.

(5) Use cotton-tipped applicators moistened with alcohol to cleanse web spaces between the

toes of a casted foot and between the fingers of a casted hand.

(6) Relieve itching under a body cast by using a scratcher made of flannel or gauze bandages which are run lengthwise to extend above and below the cast. Tie the ends together on the outside of the cast. Moving the strip back and forth provides friction to relieve the itch with no danger of actually scratching or otherwise damaging the skin. Replace a soiled strip by tying on a clean one and pulling it through. Warn the patient not to use coathanger wire loops or any material which may damage skin. Blowing cool air through the cast with an electric fan will often relieve an itching spot that cannot be reached otherwise.

5–120. Turning and Positioning the Patient in a Hip Spica Cast

The hip spica is a large, heavy body cast inclosing the patient in plaster from above the waist to, and usually including, one foot or both feet. A one-and-one-half spica includes the trunk, both hips, one thigh, and one leg; the double hip spica includes the trunk, both hips, and both legs. Genitalia, buttocks, and the toes of the casted leg, or legs, are not inclosed in plaster. The patient in a newly applied hip spica is lifted into bed and placed supine on supporting pillows. He must then be turned alternately from back to abdomen to permit the cast to dry, to redistribute body weight so as to prevent pressure areas, and to help aerate the lungs and prevent respiratory complications. In general, he is turned initially on the doctor's order the first evening of cast application; then for as long as he is in the cast, he must be turned at least 4 times daily. Until the cast is thoroughly dry, three individuals should turn the patient so that there is no strain on the patient or on the damp cast. As the patient becomes accustomed to the cast and learns to help himself, one assistant will usually be adequate.

CAUTION

> In turning at any time, the affected hip and leg (the "bad side") must always be uppermost; the patient "turns on the good side." The abduction bar of the cast (fig. 5–94) should never be grasped as this would weaken the cast.

PROCEDURE

Turning and Positioning from Supine to Prone (Damp Cast)

1. Use 3 people, 1 to be team leader, 2 and 3 to be assistants.
2. Have 4 plastic protected pillows in clean, dry, pillowcases at the side of the bed toward which the patient is to turn.
3. Tell the patient what is to be done and how he can help.
4. Stand on the side of the bed corresponding to the affected hip and, on signal, pull the pillows on which the patient is lying and the patient simultaneously toward you. (Do not, for example, move the patient's head and shoulders and then his hips; his entire body must be moved simultaneously.) Do not exert any pull on the cast.
5. Have assistants 1 and 2 go to the opposite side of the bed. Assistant 3 remains on the original side. Assistants 1 and 2 tighten the drawsheet, remove all plaster crumbs, and arrange the 4 pillows as illustrated in figure 5–94Ⓐ.

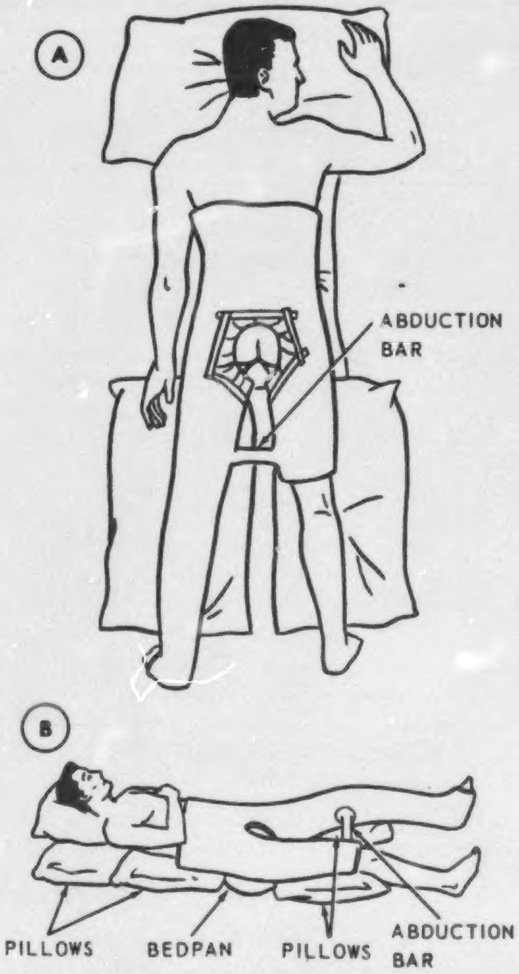


Figure 5–94. Patient in hip spica cast Ⓐ prone and Ⓑ supine position.

There must be no breaks in the pillow support for the entire length of the cast.

6. Have assistant 3 remove the pillow from beneath the patient's head. Instruct the patient to place the arm on which he is about to be turned above his head.
7. On signal from assistant 1 and in unison, turn the patient, all of his body being turned at exactly the same time. Assistant 3 slips his hands, palms up, under the patient's unaffected hip and shoulder and draws the patient toward himself while assistant 1 places his hands, palms down, on the affected hip and corresponding shoulder and simultaneously eases the patient over toward himself. Assistant 2 stands by to support the thigh and leg of the affected side on his palms as the patient is turned over onto his abdomen.
8. When turned, check the pillows supporting both legs. Always allow the toes to hang free and not be pushed in against the pillow or the mattress. In a widely abducted cast, the toes of the foot in plaster will probably hang free over the side edge of the mattress.
9. Check to make sure the cast edges are not pressing into the chest and pubis.
10. Adjust the pillow under the head for comfort and good alinement of the head, neck, and shoulders.
11. Wash the exposed back and buttocks, dry thoroughly, and rub with lotion. Slip your hand, palm down, under all edges of the cast, remove any plaster crumbs, and then gently rub the skin to stimulate circulation.
12. Check buttocks' edge of the cast for any rough spots. The cast edges cannot be finished until the cast is completely dry, but it may be possible to pull the lining down slightly, turn its edge over, and tape it temporarily.
13. Encourage the patient to lie prone for the prescribed period. This may be for an hour or more this first time. Encourage him to flex and extend his uncasted leg and to move the toes of both feet.
14. Use 3 assistants and repeat all precautions when turning again to supine position.

Pillow Supports When in Supine Position

1. Support the lumbar curve with a small thin pillow or a sheet folded into a 6-inch by 20-inch oblong. This support will prevent sagging of the cast and pressure on the abdomen.
2. Support the casted leg, or legs, along the entire length of the cast, but allow the heel to extend beyond the pillow to avoid pressure.
3. Check pillow alinement, particularly at junction of leg and body sections. This is usually the weakest part of the cast, and any sagging should be prevented.

Assisting With Urinal or Bedpan

1. Elevate the back and shoulders slightly with pillows (or gatch if permissible), to prevent moisture from running back under the cast.
2. Assist the male patient p.r.n. with placement of the urinal.
3. Use an emesis basin, slipped in place lengthwise, for a female patient for voiding. The basin is easier to place and remove than a bedpan.
4. In bedpan placement for the male or for the female patient, check to make sure that the buttocks are resting on the rim of the pan and that the head, shoulders, and back are higher than the buttocks (fig. 5-94Ⓑ).
5. When a trapeze can be used, instruct the patient to lift straight up to avoid friction on the skin while placing and removing the bedpan.
6. After using urinal or bedpan, assist the patient to clean himself thoroughly, using tissue, soap, and water. Check cast edges for soiling. If not enough cutout room has been left for proper use of the bedpan and for skin care, call this to the attention of the nurse or doctor for correction.

5-121. Instructions for Patient in an Arm or Leg Cast

Although patients with extensive body casts require more personal care than do patients with arm and leg casts, the medical specialist must continue to observe and help his more self-reliant patients. They must be taught to care for their casts, whether they are outpatients or hospitalized patients. General instructions for the patient include the following:

a. Cast Care.

(1) Do not walk on new walking casts for a period of 24 hours.

(2) Keep all casts dry.

(3) Do not alter casts.

(4) Do not remove casts.

(5) Do not put foreign objects inside of casts.

b. Prevention of Complications.

(1) To prevent swelling when a cast is applied to a limb, elevate the limb for 2 days.

(2) Report pressure points.

(3) If a cast becomes soft or broken, return for repairs.

(4) If a cast becomes too loose, return for a new one.

(5) If in doubt, return to have the cast checked.

(6) Follow the physician's orders.

c. Use Arm Sling. The type of sling required will depend upon the type of cast applied. A standard short arm cast or long arm cast can usually be adequately supported with the triangular bandage sling (fig. 5–95). If support from both shoulders is permitted, apply the sling as illustrated in figure 5–95Ⓐ, making sure the knot is tied to one side of the neck to prevent pressure on the affected side. To support the casted arm without pressure on the clavicle or shoulder on the affected side, apply the sling as illustrated in figure 5–95Ⓑ, making sure the knot does not cause pressure on the scapula. When the cast includes the elbow, the cast is usually applied with the elbow flexed at a 90-degree angle, and the casted arm and hand is therefore supported at waist level. A hanging cast (fig. 5–96) is not supported with a triangular sling. At the time of cast application, a wire loop is incorporated into the cast, and the cast is suspended from the neck by a padded tubular loop alined to the midline of the body. The neck loop ends are inserted through the cast loop in opposite directions and tied to the cast loop to suspend the cast at the height determined by the physician to maintain the desired gravity-pull.

d. Walking Casts. A walking iron or rubber heel is incorporated into the leg cast of a patient permitted to bear weight on the casted leg. A cast sock should be used. A well-fitting shoe should be

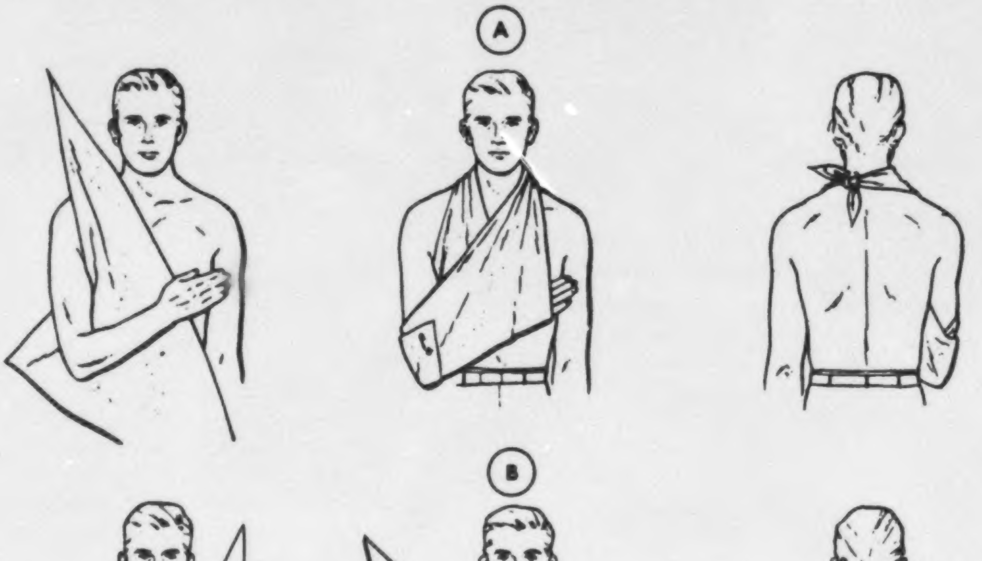


Figure 5–95. Applications of triangular bandage to form a sling (two methods).

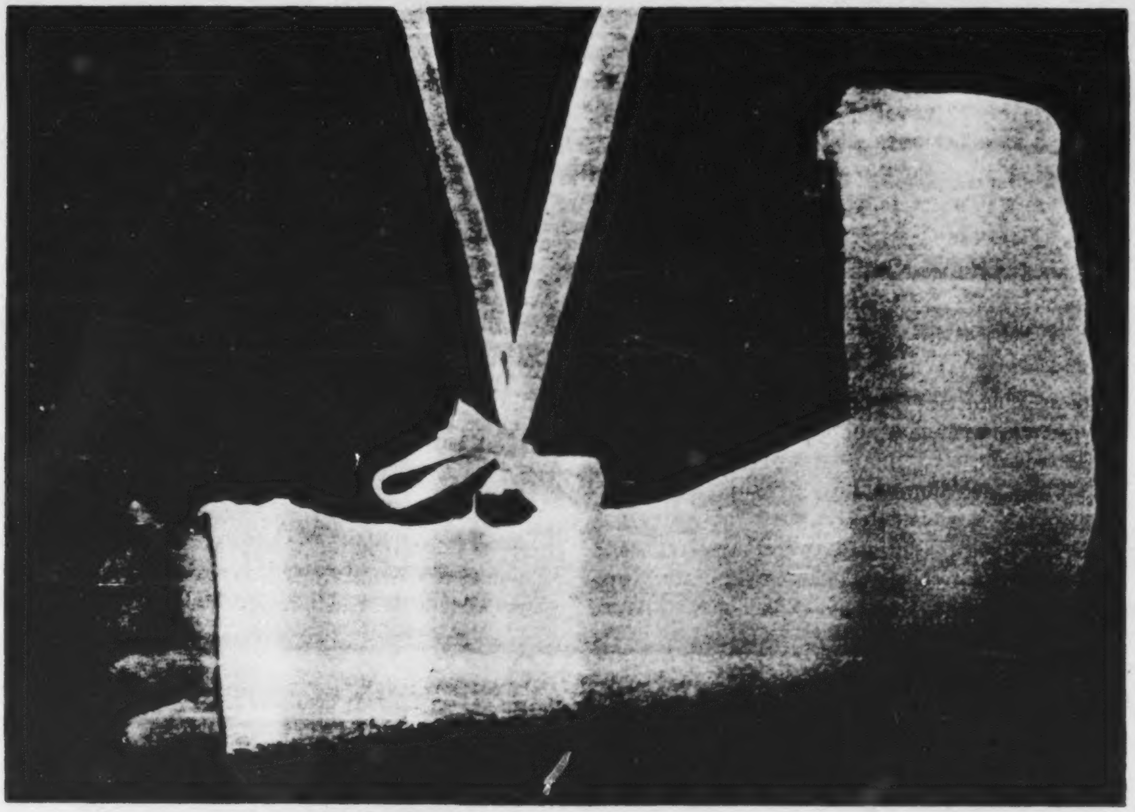


Figure 5-96. The hanging cast support.

worn on the uncasted foot and an elevator is usually attached to the shoe to maintain normal body alinement. Remind the patient to walk with his casted foot straight forward and not in eversion. The cast edges at the toes should be watched for weakened, cracking areas. The patient must be reminded to elevate the leg in the cast when sitting; walking stimulates circulation, but some swelling may develop when the patient sits with the casted leg hanging down.

5-122. Cast Cutting and Cast Removal

Casts may be cut (but the entire cast may not be removed from the casted area) for different reasons—to allow for wound dressings, to examine a painful area, or to relieve pressure. The medical specialist may be required to assist with cast cutting at the bedside as an emergency measure to relieve pressure.

a. Bivalving the Cast. Bivalving is the recommended method for emergency cutting of the cast to relieve pressure. In bivalving, the cast must be cut along its entire length on two sides, medial and lateral, and the base material (lining or padding) cut completely down to the skin along its entire length. If the cast or the lining is split only part way, the congestion will be increased and additional tissue damage will occur. To cut the cast, use a knife, a hand cutter, or an electric cast cutter; use bandage scissors to cut the base material down to the skin. To use a knife for emergency cast cutting, follow these steps—

(1) Make a shallow groove to indicate the cutting lines on both sides of the cast.

(2) Apply water or peroxide along the cutting lines with a syringe to soften the plaster.

(3) With the knife, cut through the successive layers of plaster along the cutting line. Do not attempt to slice through all layers at once.

(4) With scissors, cut through the base lining material down to the skin. Cut every thread of the lining material completely through, since the lining is sometimes the source of the trouble.

(5) Tape the bivalved cast together loosely to maintain support of the casted part until further instructions are obtained.

b. Windowing the Cast. This may be done on specific order, but it is a more hazardous procedure than bivalving because the underlying tissue may bulge through the window opening, causing "window edema." If a window is cut, the piece of plaster removed should be saved. The doctor indicates the area to be windowed. After he examines and treats the underlying area, a padded compression dressing may be applied over the exposed skin area and the cutout piece of plaster bound in place to the cast to prevent "window edema."

c. Patient Care After Cast Removal.

(1) Continue to provide support to joints and normal body curves. The muscles will have become weakened from disuse, and although movement is encouraged, support is necessary. Firm pillow supports when patient is in bed, a sling for his arm when the cast is removed, and cotton elastic bandages for his arm or leg may be necessary.

(2) Avoid soaking or any vigorous attempts to remove skin exudate and crusty scales which are commonly present when the cast has been on for several weeks. Application of oil for several days after cast removal may be recommended.

(3) If a bivalved cast shell is to be used for support, tape the edges and check the lining. Remove all plaster crumbs. Use care in storing the cast shell when not in use. A spica or body cast shell is bulky and easily damaged. The safest storage place may be on a clean sheet under the bed or the cast may be hung from a hook on the wall. (The Balkan frame may seem to be a handy rack for the cast shell, but this could be hazardous if the cast falls on the patient or on another person.)

5-123. Care of the Patient in Traction

a. General. Traction is used to promote and maintain alinement of broken bones and to relieve muscle spasm and pain. It is an exertion of pull usually accomplished by traction apparatus. To maintain traction and body alinement, countertraction (exertion of pull in the opposite direction) must be present. When traction is applied to a lower extremity, the foot of the bed may be elevated when the patient's body weight supplies countertraction.

b. Major Methods of Applying Traction. The major methods of applying traction are referred to as skin traction and skeletal traction.

(1) *Skin traction.* In skin traction, adhesive material is applied to a limb, or a halter is fitted to the patient's head or pelvis. The adhesive material or the halter is then attached to traction apparatus, and force is exerted by means of a pulley and weights.

(2) *Skeletal traction.* In skeletal traction, force is exerted directly on the bone by means of tongs inserted in the skull for reduction and maintenance of bone alinement in cervical spine injuries or by means of a pin or wire inserted through bone distal to the fracture in extremity fractures. The tong, pin, or wire is then attached to the traction apparatus, and force is exerted by means of pulleys and weights. A greater pull can be exerted by means of skeletal traction than by skin traction.

c. Preparing the Patient and His Unit for Traction. There are many local variations in traction procedures, depending upon the preferences of the orthopedic surgeon. The nursing procedures described for the care of patients in traction are guidelines that are subject to amendment by specific orders of the medical officer. In general, in AMEDD hospitals, an orthopedic specialist assists the doctor in application of traction. The medical specialist may be required to assist occasionally, but his primary responsibility lies in nursing care. In order to give effective nursing care, he should have an understanding of the basic forms of traction used and recognize some principal features of standard traction apparatus. This is because in caring for the patient he is responsible for recognizing and reporting defects at once so that the defect can be corrected by qualified personnel.

PROCEDURE

1. Prepare the bed with a thin, firm mattress and an orthopedic bedboard. Check as to whether shock blocks or other elevators are to be used at the head or foot of the bed. The patient is often positioned on an incline to provide countertraction through his own body weight.
2. Provide a footboard or sandbags to support the foot that is not in traction. Foot support for the leg in traction is usually provided by means of the footrest when the traction is applied.
3. Use a complete overhead Balkan frame with trapeze, or use only an orthopedic foot or head bar, depending on the type of traction to be used.
4. Provide two or more firm, plastic-protected pillows.
5. Make the foundation of the bed with a drawsheet. Omit the top linen, or fold it back evenly

to the edge of the mattress to allow for necessary adjustment according to the placement of the traction ropes.

Preparing the Patient

1. Remove pajama trousers for application of traction to lower limb. Provide a towel for a loin cloth drape.
2. Remove pajama coat for application of arm or cervical traction; if the coat is used, it can be placed back to front.
3. Offer bedpan or urinal before the application procedure starts.

5-124. General Observations—Traction Apparatus

In caring for the patient in traction, the following points should be observed routinely and any defect noticed should be reported and corrected:

a. Weights. The weights must hang free. Bumping into them must be avoided because it causes them to swing back and forth. Each weight bag must be tied securely to its rope.

b. Ropes. There should be no frayed spots or knots in the running length and no dragging on the bedframe or bedcovers. Ropes should not rest against each other.

c. Pulleys. The rope should rest securely in the pulley grooves. Pulley clamps must be securely attached to the bedframe and must never be moved except as directed by the doctor.

d. Spreader Bars. The spreader bars should cause no pressure on adjacent skin areas.

e. Foot Plate. The foot plate should maintain and support the foot in neutral position, with no pressure on either side of the foot, the heel, or toes. It must not rest against the end of the bed —this interferes with the traction pull.

f. Trapeze. This is suspended from the overhead bars so that the patient can reach and grasp it without strain and without twisting out of alinement.

g. Hammocks, Slings, and Halters. These should be free of wrinkles and cause no pressure on bony prominences or joints. If padding material is used, it must be clean, dry, and free of wrinkles and crumbs.

5-125. General Nursing Measures—Skin Traction

a. Skin Preparation. Check with the doctor as to whether the skin is to be shaved. Shaving is not always advised because of the possibility of skin irritation or subsequent ingrowing hair problems. The doctor may request that the skin be painted with compound tincture of benzoine; if this is done, it must be dry before the adhesive or moleskin is applied.

b. Application of Traction.

(1) Assist with application of skin traction and arrangement of traction apparatus as directed by the doctor.

(2) Understand the nature of the traction and the position and permissible patient movement to maintain the desired traction pull. Position and permissible movement differ according to the type of traction used, and these factors determine the planning of basic nursing care.

BUCK'S EXTENSION

This form of skin traction to the lower limb (fig. 5-97) provides for straight pull through a single pulley attached to a crossbar at the foot of the bed. The limb in traction lies parallel to the bed. The foot of the bed is elevated to provide countertraction and to help keep the patient from being pulled down to the foot. Usually, in Buck's extension the patient is not permitted to turn and must remain flat on his back.

Special Nursing Observations and Care

1. Check alinement of leg to maintain a straight pull from the rope attached to the center of the spreader block to the pulley mounted on the foot bar of the bed.
2. If pillow support for the leg in traction is prescribed, use a thin, firm pillow, leaving the patient's heel free to avoid pressure. The doctor may specify that only a plastic protector (no pillowcase) is to be used on the pillow. The plastic eliminates friction, and the traction is therefore more efficient.
3. Check tape strips visible on the lateral and medial sides of the leg and report immediately if tape is not adhering to skin or is slipping downward. Weight adjustment may be needed.
4. Check bandage wrappings to make sure they have not slipped downward, causing pressure on dorsum of foot and on Achilles tendon.
5. Check tape attachments to spreader block to make sure tape is not pulling away from malleoli or cutting into lateral and medial sides of the foot. If either condition is noted, the foot may be out of alinement or the spreader may need replacement.

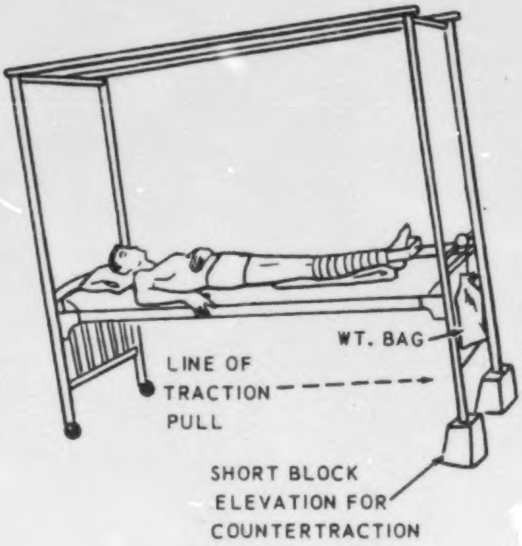


Figure 5-97. Buck's extension.

6. Observe the exposed toes for color, edema, coldness, or numbness.
7. Observe the foot for any tendency to turn in inversion (toward the midline).
8. Listen to any complaint of a burning sensation on the lateral side of the leg. This may be an indication of peroneal nerve involvement. This nerve lies close to the lateral surface of the leg at a point just below the knee and can be damaged by compression, causing paralysis of the foot.
9. To give a patient back care when he cannot turn or lift himself from the mattress by means of a trapeze, depress the mattress with one hand, while slipping the other hand under his back to reach all the skin area.
10. To place the patient on a bedpan, have an assistant support the patient while the mattress is depressed and the bedpan is slipped into place. Slip a sheet-roll support in the lumbar curve to keep the back level with the bedpan. Check to see that the skin is clean and dry after the bedpan has been removed.
11. Check the uninvolved limb to make sure it is not in a position of external rotation of the hip. Encourage the patient to toe in at intervals. Provide sandbags for foot exercise part of the time and encourage the patient to push against the firm bags.
12. Encourage and assist the patient to take 10 to 15 deep breaths every waking hour to prevent hypostatic pneumonia (pneumonia resulting from immobilization).
13. To change the foundation sheet and drawsheet, start on the side opposite the traction, and pull the linen smoothly through under the side in traction. Fold back the top linen neatly toward the center of the bed to avoid any contact with traction ropes. Use a separate small cover if the limb in traction needs to be covered for warmth; a bath towel or pillowcase may be adequate.
14. Place the bedside stand, the signal cord, and personal articles where the patient can reach them without twisting or turning.
15. Encourage the patient to reach overhead and grasp the head bars to exercise his shoulders and help his chest muscles expand.

RUSSELL TRACTION

In this form of skin traction (fig. 5-98), a system of suspension and traction pull is used. Adhesive strips are applied as in Buck's extension. In addition, the knee is suspended in a canvas sling. A felt pad is usually placed between the sling and the skin. A rope is attached to a spreader bar above the sling. This rope passes over a pulley which is positioned on an overhead bar and is then directed to a system of three pulleys at the foot of the bed: first to the pulley on the bed foot bar, next to the pulley on the foot spreader bar, and then back to a second pulley on the bed foot bar. There is an upward pull from the hammock pulley and a forward pull from the foot of the bed pulleys. In Russell traction, the angle between the thigh and the bed is approximately 20°—there is always slight flexion of the hip and knee. The

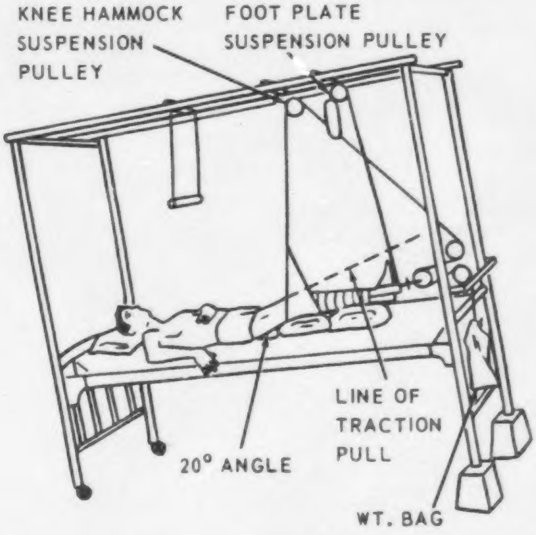


Figure 5-98. Diagram of Russell traction.

advantage of Russell traction is that some movement in bed is permissible. The patient can turn slightly toward the side in traction for back care, for placement on the bedpan, and for bedmaking.

Special Nursing Observations and Care

1. Check the popliteal space for any signs of pressure from the hammock such as ridging of the skin, redness, pain, or any discomfort.
2. Check the pillow supports—one pillow is to be lengthwise under the thigh and a second pillow under the leg, with the heel free.
3. Keep the patient from sliding down in bed. Countertraction, with the foot of the bed elevated, helps to prevent this.
4. Check all tape and bandage points as in Buck's extension.

PELVIC TRACTION GIRDLE

The pelvic traction girdle is ordinarily used for treatment of low back pain and muscle spasm. It is fitted snugly and evenly over the iliac crests. The traction straps, extending on the lateral side of each thigh, are hooked to a separate rope at about midthigh level, and each rope leads to a separate but equal weight at the foot of the bed. The foot of the bed is usually elevated to provide countertraction.

Special Nursing Observations and Care

1. Keep the girdle and the skin under the girdle clean and dry. Padding is usually avoided, unless the patient is very thin and the iliac crests are very prominent. Orders will specify when the pelvic girdle may be removed for skin care.

NOTE

> Some patients are allowed out of bed for bathroom privileges only, and then traction is resumed.

2. Protect and support the feet. Foot exercises are usually encouraged, but there must be no contact with the traction ropes.

PELVIC TRACTION SLING

The pelvic traction sling is used for treatment of pelvic fracture. The patient is placed in a canvas sling (hammock) which is suspended by a tension spring attached to an overhead frame bar. The pelvis is suspended so that it is just off the mattress.

Special Nursing Observations and Care

1. Place padding along the skin in contact with the sling edges as needed to relieve pressure on the coccyx.
2. Keep the sling, the skin, and the padding clean and dry. It is usually permissible to fold the sling back in order to place the patient on a bedpan and to give skin care.

CERVICAL TRACTION HALTER

A canvas head halter is used for treatment of affections of the cervical spine. The halter fits snugly under the chin and at the back of the head against the occipital protuberance. Traction straps are attached to a centrally placed spreader bar to which the pulley rope is attached, and the weights prescribed keep the patient's neck and cervical area in a neutral position or as specified by the medical officer.

Special Nursing Observations and Care

1. Reverse the bed from head to foot to provide easier access to the patient's head.
2. Place the head of the bed far enough from the wall to insure free suspension of weights and free access to the patient.
3. Elevate the head of the bed on shock blocks or other elevating devices to provide countertraction.
4. Do not permit the patient's head or the spreader bar of the halter to rest against the bedrail.
5. Check frequently to insure that the chin strap is not pressing on the throat and that the spreader bar is not causing pressure on the angle of the jaw and the ears.
6. Slip your hand between the halter and the patient's skin to gently massage his chin, his jaw, and the back of his ears. Depress the mattress with one hand and slip the other hand to his head to massage the back of his scalp.
7. Give the patient back care at least q.2h. The doctor always specifies the amount of turning or shifting of the patient's weight. If no turning is permitted, depress the mattress with one hand, and wash and massage the patient's back and buttocks with the other hand.
8. Feed the patint slowly and with great care. Remind him to face forward and not to turn toward the spoon, fork, or drinking tube. Allow plenty of time for him to chew and swallow.
9. Keep suction equipment on hand for immediate use to prevent aspiration when feeding or giving mouth care. Remember, if he chokes, he cannot be turned or raised forward.

10. Remind the patient to take 10 deep breaths every hour when awake in order to aerate his lungs.
11. In bedmaking, loosen top foundation linen and draw it downward, head to foot.

5–126. General Nursing Measures—Skeletal Traction

a. Crutchfield or Vinke Tongs. These tongs are used for skeletal traction in the treatment of fractures of the cervical spine. The tong points are inserted in the parietal area of the skull (just in the outer layers of bone), and the tong is then attached to the pulling device. The procedures may be done under local anesthesia in the operating room or on the ward. When done on the ward, operating room personnel may be responsible for the head prep and for assisting with the insertion procedure. With skeletal skull traction, the nursing care of the patient is usually less difficult than when a halter is used—the patient's face and head are relatively free of pressure and some turning in "log-roll" fashion (head, shoulders, and pelvis turned simultaneously) may be permissible for back care and bedmaking.

(1) Prepare the bed, head to foot, as for cervical halter traction.

(2) Use an alternating pressure pad if one is available, when the patient is in a conventional bed. (The patient in tong traction may be immobilized for a long period, so he may be placed on a Foster frame.)

(3) Do not disturb or remove the dressings on the tong insertion wounds unless so ordered. Inspect both areas for drainage. Small dry dressings (or a surgical plastic spray) are usually all that are used. The doctor may request that the hair be kept shaved at the insertion points.

(4) Feed the patient slowly and with great care. Remind him to face forward and not to turn toward the spoon, fork, or drinking tube. Allow plenty of time for him to chew and swallow.

(5) Be constantly alert for any signs of respiratory distress. Instruct and assist the patient to take 10 deep breaths every hour.

b. Thomas Splint and Pearson Attachment (Skeletal Traction). The combination of skeletal traction and balanced suspension by means of the Thomas splint is widely used for treatment of fractures of the femoral shaft (fig. 5–99). This method of treatment provides considerable freedom of body movement while maintaining efficient traction on the injured limb. Some special points in relation to nursing care are summarized as follows:

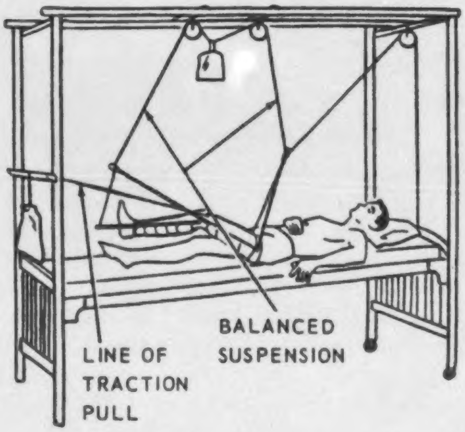


Figure 5–99. Skeletal traction-suspension: Thomas leg splint.

(1) *Skeletal traction wire (Kirschner) or pin (Steinmann).* The wire or pin insertion is always an aseptic surgical procedure, and is usually done in the OR. A local or a general anesthetic is used, and all preoperative and postoperative precautions must be taken. The wire or pin is inserted through the bone distal to the fracture and out through the skin on the opposite side. The small wounds made for the wire or pin insertion are dressed and these dressings must not be disturbed —the areas are observed for drainage or pain, but a "hands-off" policy is maintained. Corks should be placed over the sharp protruding wire ends. The patient must be reminded not to touch the dressings or any of the attachments.

(2) *Thomas Splint.* The half-ring (Army leg splint) is applied in various ways: with the ring fitted posteriorly against the ischium or anteriorly in the groin. The thigh rests in a canvas or bandage strip sling, with the popliteal space left free. Contrary to usual practice, the leather ring should not be padded or wrapped for protection; the padding gets damp and soiled and causes skin irritation. If kept smooth, dry, and polished, the leather of the ring is designed to rest against the skin and is moisture resistant. To give skin care, move the skin back and forth to wash under the ring, then dry the skin and ring thoroughly.

(3) *Pearson attachment.* This is attached by clamps to the Thomas splint at knee level. A canvas or bandage-strip sling supports the lower leg and provides the desired degree of knee flex-

ion. A foot plate is attached to the distal end of the Pearson attachment to support the foot in neutral position. The heel is always left free.

(4) *Line of pull.* Traction in line with the long axis of the femoral shaft is maintained by the rope, pulley, and weights attached to the skeletal tractor (U-shaped clamp), which is fitted onto the skeletal pin. Countertraction and balanced suspension are provided by the ropes, pulleys, and weights attached to the Thomas splint. When all is operational, the thigh and Thomas splint will usually be suspended at a 45-degree angle with the bed, and the lower leg and Pearson attachment will be suspended horizontal with the mattress. The patient may sit up, turn toward the traction side, and raise his hips above the bed by means of the trapeze and still maintain the line of traction.

(5) *Additional treatment.* The orthopedic surgeon will often order a rope, pulley, and weight arrangement to provide assistive exercise for the knee of the affected leg. The patient pulls on the designated weight suspended over his head to exercise his knee.

c. Arm Traction. In arm traction, either skin or skeletal, the upper arm is extended at a right angle to the bed, and the forearm is flexed and suspended over head. Countertraction is provided by tilting the bed sideways away from the traction apparatus; low shock blocks are placed under the head and foot on the side corresponding to the traction. The patient requiring this method of treatment usually has a severe injury to the humerus and elbow. Several important nursing responsibilities should be emphasized:

(1) Check the radial pulse on the affected side and compare it with the pulse on the unaffected side. Circulatory and nerve impairment is common in this type of injury, and a weak or absent pulse must be reported immediately.

(2) Check the hand and fingers for circulatory impairment. Swelling and blueness of the nails are danger signs. Emergency treatment for relieving these symptoms consists of removing the traction apparatus and bringing the arm into extension (arm at the side).

(3) Check to see that the elevated hand is kept in a position of function and that there is no pressure from the spreader bar or suspension apparatus. A hand bar for the patient to grasp to facilitate position and finger exercise is usually provided.

(4) Check for pressure points at the wrist.

(5) Know what movement in bed is permissible. The patient is usually required to remain flat, with no shoulder elevation. Some turning toward the traction side may be permissible for back care or bedmaking.

(6) Use caution in moving when at the bedside of a patient in traction in order to avoid bumping the weights or striking against the protruding traction apparatus. Extra space between beds is usually required.

5–127. Amputation Postoperative Care

Surgical amputation of lower or upper limbs is done to remove dead or unhealthy tissue that cannot be treated by any other means. In many instances, amputation is done as a lifesaving measure. The amputation may be necessary because of loss of blood supply due to severe crushing injury or to severe peripheral vascular disease; clostridial infection such as gas gangrene; or cancer. In some instances, amputation is advised to remove a deformed and useless limb to permit the fitting of a functional prosthesis. Whatever the reason, amputation is a major operative procedure. Preoperative and postoperative care is part of a long-range plan for the patient's rehabilitation. Members of the nursing team usually work closely with physical therapists who conduct on-ward patient teaching and physical conditioning programs until the patient is well enough to go to the physical therapy clinic. Continuous care and teaching is needed as the patient progresses to the point where he is fitted with a prosthesis and learns how to use it. The medical specialist needs to know some general principles of care, particularly of the amputation stump.

NOTE

> Although only lower limb amputations are discussed here, it is important to realize that an upper limb amputation is often a greater handicap and requires equal consideration.

GENERAL NURSING MEASURES—EARLY POSTOPERATIVE CARE (LOWER LIMB AMPUTATION)

1. Carry out routine postoperative nursing measures as for any major operative procedure.
2. Keep a heavy tourniquet attached in clear view at the head or foot of the bed. Know how to apply the tourniquet immediately if sudden hemorrhage occurs. Request the responsible nurse or medical officer to demonstrate the tourniquet procedure to be used.

3. Watch for hemorrhage from the stump. Do not cover the stump dressing with bed clothing. Watch for bright red staining, report it immediately, and continue to watch for any increase in extent and rate of spread of the blood stain.
4. Maintain the prescribed position of the stump in traction, on a splint, or with prescribed pillow elevation. (If pillow elevation is prescribed for the first 12 to 24 hours postoperatively to lessen edema and oozing, the pillow is usually removed as soon as possible to prevent flexion contracture of the hip.)
   a. *Skin traction.* Following emergency amputation when the stump wound is not closed with a skin flap, a stockinette-skin-traction device is usually applied in surgery. Continuous traction is maintained to prevent retraction of the skin and muscle from the wound edges until closure is possible in a follow-up operation.
   b. *Splinting.* A padded-board knee splint may be used to maintain extension of the knee joint in below-knee amputations. The patient may have severe muscle spasms, and he can also develop a pressure sore from contact with the splint. Check the padding. Know when the splint may be removed for skin care and position change and exercise.
5. When change of position is permissible (usually within 24 hours postoperatively), turn the patient at regular intervals and at least twice daily to lie flat on his abdomen. Do not turn him just toward his abdomen. Check to see that both hip bones rest evenly on the mattress; this position helps to correct any tendency toward flexion contracture of the hip. While lying prone, encourage the patient to adduct the stump at intervals, moving it inward toward the unaffected leg. This exercise will help to correct the usual tendency toward abduction.
6. Encourage prescribed exercises to preserve range of motion of all joints of the affected limb and of the three other limbs to prepare the patient for crutch walking. Strengthened muscles are needed to use crutches effectively. Arms and shoulders must be exercised as well as the affected and unaffected leg. Alternating use of the trapeze, which strengthens biceps muscles, with pushup exercises to strengthen triceps muscles is usually advised. When a patient is not strong enough to do pushups, less strenuous exercise is often prescribed; *for example,* when lying supine he can lift shot bags held on his palms while keeping his arms extended.

STUMP BANDAGING

When the stump wound is healed, the stump must be conditioned and shaped for proper fitting of a prosthesis. Bandaging with a special technique is used to shrink and mold the stump to a smooth, conical shape. Patients are normally taught how to apply the bandage by a physical therapist. The recommended procedure usually is to remove and reapply the bandage twice daily and to wash and expose the stump to air before reapplying. Nursing supervision and assistance with stump bandaging on the ward is, therefore, customarily needed. During the shaping process, the bandage is worn day and night. Different methods are used in applying the bandage. One method of application for below-knee (B/K) amputation and for above-knee (A/K) amputation is illustrated in figure 5–100. The cotton elastic bandage must be applied to provide equal, firm compression in a crisscross or spiral pattern, with no circular turns that can constrict circulation.

5–128. Assisting With the Use of Crutches

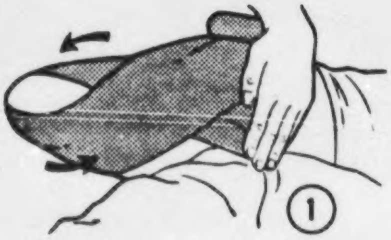
The use of crutches is a complicated procedure that is usually taught by a physical therapist. There are occasions, however, when the medical specialist may have this responsibility, particularly when crutches are to be used temporarily by a patient in good physical condition—*for example,* a patient who has been treated as an outpatient. The medical officer prescribes the use of crutches and the gait (crutch-walking) method to be used. The prescribed gait depends upon the amount of weight bearing permitted on the affected leg. The gait most commonly taught by the medical specialist is the "3-point" gait, with no weight borne on the affected leg. The crutches are moved with the affected limb (fig. 5–101).

PROCEDURE

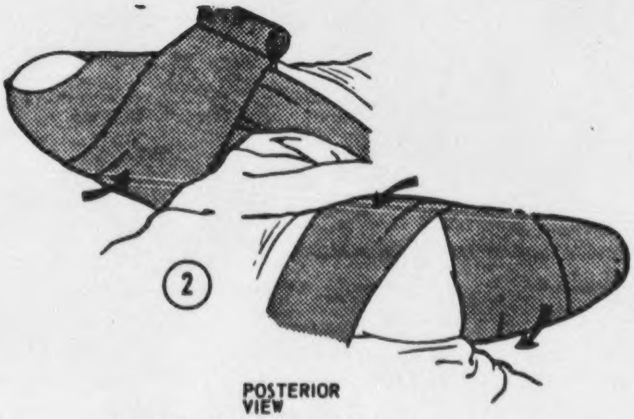
Measuring for Crutches

Crutches need two adjustments—the length of the crutch and the position of the hand grip. Rubber tips should be on the crutches, and the patient should wear a shoe on the unaffected side for the measurement.

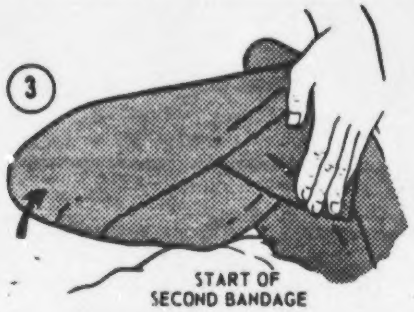
1. Have the patient lie supine, hands at sides, wearing a shoe on the unaffected foot.
2. Using a tape measure, measure from the border of the axilla to the heel of the shoe plus 2



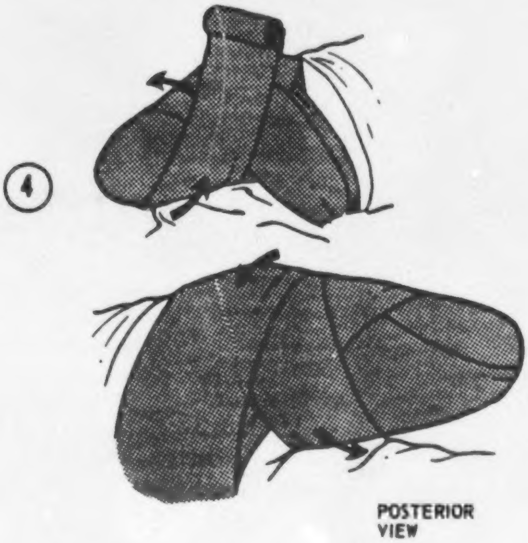
START FIRST BANDAGE IN THE INGUINAL AREA AND PROCEED DIAGONALLY AND LATERALLY OVER THE DISTAL STUMP. COVER THE POSTERIOR MEDIAL CORNER, THEN CONTINUE DIAGONALLY AND ANTERIORLY UP TO THE ANTERIOR ILIAC CREST, POSTERIORLY AROUND THE PELVIS. THERE WILL BE AN EXPOSED AREA OVER THE DISTAL LATERAL CORNER OF THE STUMP.



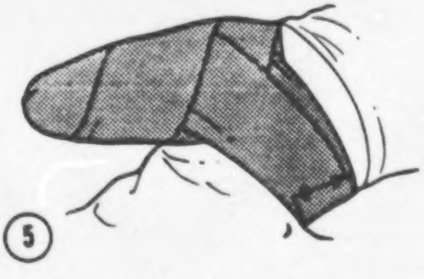
FOLLOWING THE ENCIRCLING TURN AROUND THE PELVIS, BRING THE BANDAGE DIAGONALLY, LATERALLY, AND POSTERIORLY AROUND THE PROXIMAL STUMP AND UP HIGH INTO THE ADDUCTOR AREA MEDIALLY. CONTINUE UPWARD OVER THE ANTERIOR ILIAC CREST AND POSTERIORLY AROUND THE PELVIS.



START THE SECOND BANDAGE SLIGHTLY LATERAL TO THE FIRST, PROCEED DIAGONALLY AND LATERALLY TO COVER THE DISTAL LATERAL CORNER WHICH WAS LEFT EXPOSED ON PREVIOUS TURNS. CONTINUE AROUND DISTAL END TO ANTERIOR ASPECT AND OBLIQUELY UPWARD TO THE ANTERIOR ILIAC CREST AND AROUND THE PELVIS.



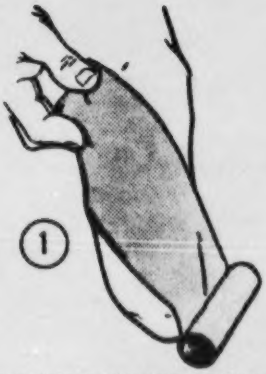
CONTINUE WITH FIGURE-OF-EIGHT TURNS, WITH PRESSURE EXERTED DISTALLY AND GOOD COVERAGE IN THE GROIN TO PREVENT ADDUCTOR ROLL.



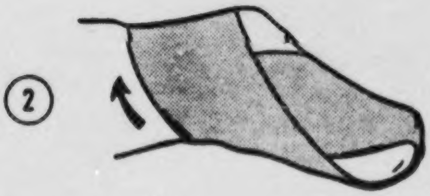
COMPLETED BANDAGE.

Ⓐ RIGHT ABOVE KNEE (A/K)

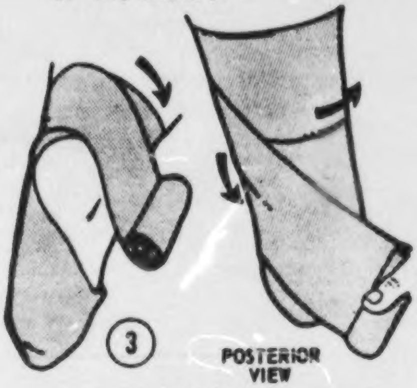
Figure 5–100. Stump bandaging.



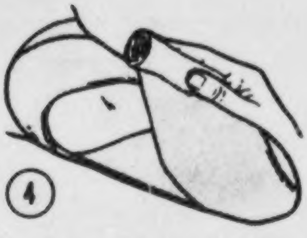
START FIRST BANDAGE PROXIMAL TO THE LATERAL FEMORAL CONDYLE AND PROCEED DIAGONALLY ACROSS THE ANTERIOR ASPECT OF THE STUMP.



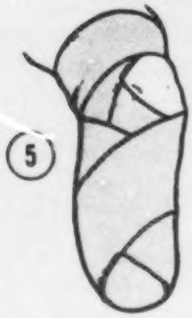
CIRCLE AROUND THE DISTAL PORTION OF THE STUMP AND CONTINUE DIAGONALLY ACROSS THE POSTERIOR ASPECT TO ANCHOR THE END OF THE BANDAGE. ENCIRCLE THE KNEE PROXIMAL TO THE PATELLA, AVOIDING A CONSTRICTING TURN.



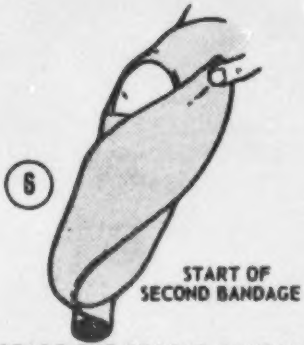
BRING THE BANDAGE MEDIALLY OVER THE MEDIAL TIBIAL CONDYLE AND DIAGONALLY ACROSS THE POSTERIOR ASPECT OF THE STUMP.



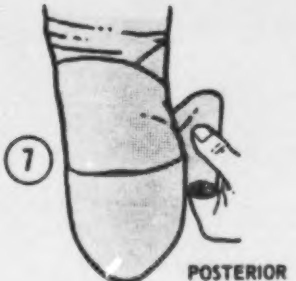
COVER THE LATERAL DISTAL CORNER OF THE STUMP AND PROCEED UPWARD DIAGONALLY ACROSS THE MEDIAL TIBIAL CONDYLE TO ENCIRCLE THE PROXIMAL KNEE AREA AGAIN.



CONTINUE WITH FIGURE-OF-EIGHT TURNS, LEAVING THE PATELLA EXPOSED.



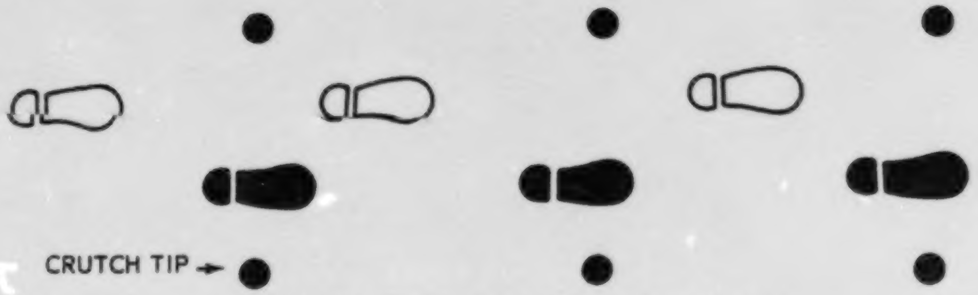
START THE SECOND BANDAGE PROXIMAL TO THE MEDIAL FEMORAL CONDYLE AND PROCEED DIAGONALLY ACROSS THE TIBIA TO THE LATERAL CORNER OF THE STUMP.



CONTINUE WITH FIGURE-OF-EIGHT TURNS, EXERTING PRESSURE DISTALLY AND AVOIDING CONSTRICTION PROXIMALLY.

Ⓑ RIGHT BELOW KNEE (B/K)

Figure 5-100—Continued.



(SHADED PRINT IS AFFECTED EXTREMITY.)

Figure 5-101. The 3-point gait.

inches. Adjust the crutch shaft to this measurement.

3. Ask the patient to place his arm over the crutch and grasp the handbar so that his elbow is in approximately 30 degrees flexion and the palm of his hand is flat on the handbar. Adjust the handbar if necessary.

Teaching Use of Crutches for "3-Point" Gait

1. Be sure a shoe is worn on the unaffected foot.
2. Be sure the crutches have rubber tips in good condition.
3. Assist the patient to stand upright, bearing weight on his good leg.
4. In standing position, place the crutch tips about 6 inches ahead and to the side of the toes. This 3-point contact with the floor is the tripod position (fig. 5-102).
5. Tell the patient to lean forward slightly and to shift his weight to his hands. He should practice shifting his weight to his hands and then back to his good leg before attempting to swing his body to a position just ahead of the crutches.
6. Check to make sure his weight is borne on the palms of his hand, not by leaning the axillae on the crutches. Paralysis of the radial nerve ("crutch paralysis") may result if weight is borne in the axillae. When crutches are properly adjusted, you should be able to slip two fingers between the top of the crutch and the patient's axilla.
7. Encourage the patient to take short swing-through steps, landing just beyond the crutches. In this way, weight is shifted back to the good leg and the crutches are then advanced to tripod position in preparation for the next step.
8. Stand in back of the patient when he is learning to use crutches. If he begins to fall, grasp his waist and support his weight against your body.
9. Remind him to check the way ahead to see that there are no wet or slippery places and no obstacles, and then to walk with head erect.

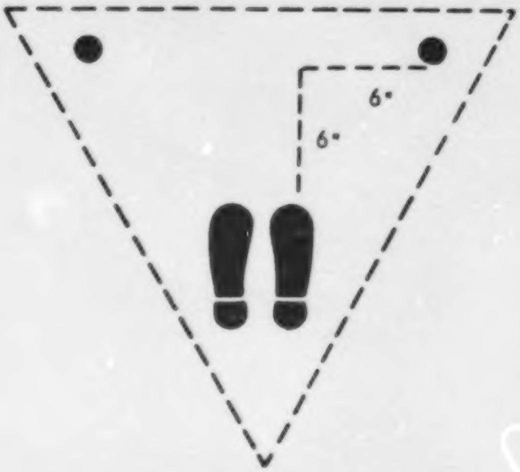


Figure 5-102. Standing position (tripod).

5-129. Use of Turning Frames

a. General. Turning frames are devices used to provide immobilization and to facilitate nursing care for the patient who, while immobilized, needs frequent changing from supine to prone position. A turning frame is used in the treatment of patients with such conditions as extensive burns, spinal and pelvic fractures, tuberculosis of the spine (Pott's disease), and spinal cord injury. The use of a frame is so important in the initial medical care of a cord-injury patient that improvised frames fashioned from standard canvas litters are used under combat conditions when commercially manufactured frames are not available. The major advantages in the use of a frame are to prevent complications such as—

(1) *Pressure sores.* With relief of pressure from body weight on pressure areas (fig. 5-24), the blood supply to the skin is improved. Larger body areas are also exposed for complete skin care.

(2) *Respiratory congestion.* Rotation of the patient to face-down position aids gravity in loosening and ridding the lungs of fluid accumulations. The patient can cough and expectorate more effectively in prone position.

(3) *Kidney and bladder complications.* Rotation of the patient aids gravity in the elimination or urine sediments (heavy waste materials that may form kidney or bladder stones).

b. Types of Frames.

(1) The Foster reversible orthopedic bed and the Stryker turning frame are commonly used. Both are double frames which are rotated on the longitudinal (side-to-side) axis. Their operation is similar in principle, with variations in the details of preparing the frame for use and in the turning method; *for example,* the Foster bed can be adjusted for hyperextension, while the Stryker frame requires separate hyperextension frames.

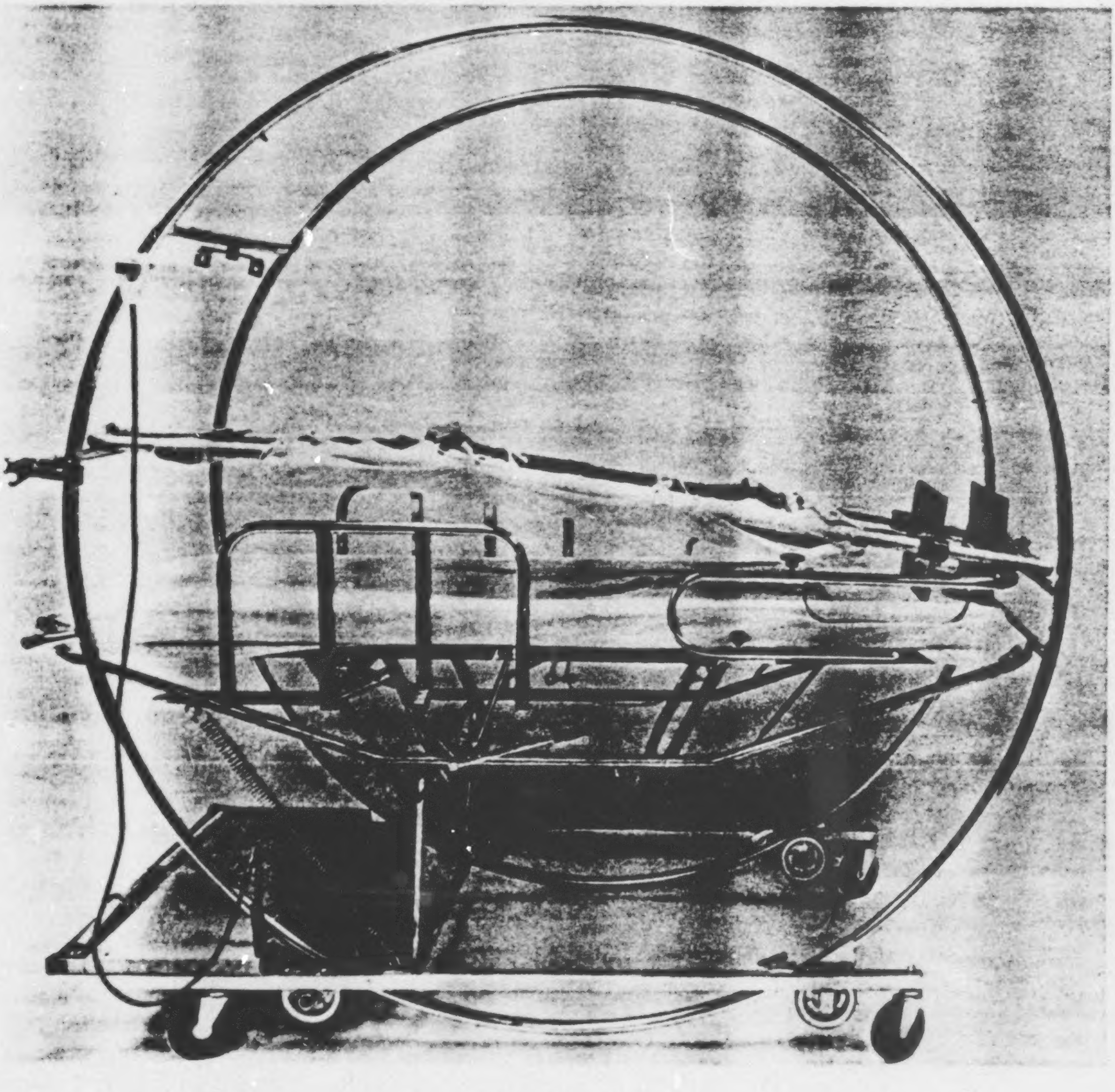


Figure 5-103. CircOlectric bed.

As for similarities, both have a rotary-bearing turning apparatus at each end and, when traction is used, it can be maintained during the turning process, and both can be elevated at either the foot or head end by extending the legs of the frame and inserting lockpins in holes at the selected height. The patient is sandwiched in between two canvas-covered frames when he is turned. The frame on which he lies prone is the anterior frame; the one on which he lies supine is the posterior frame.

(2) Improvised litter frames. Two canvas litters, padded with smoothly folded Army blankets are prepared for use as an anterior and a posterior frame. The frames are placed on sawhorses for greater stability but can be used on standard litter brackets.

(3) Stryker CircOlectric hospital bed. At the present time the CircOlectric bed (fig. 5–103) is a nonstandard item that is used in some AMEDD hospitals. It is an electrically powered apparatus which can be used as a turning frame for vertical (end-over-end) rotation, as a tilt table to support the patient in a partially erect or an erect stance, and for unrestricted gatch positioning. (Complete operating instructions are provided in an illustrated manual provided by the manufacturer.)

5–130. Foster Reversible Orthopedic Bed

The Foster reversible orthopedic bed (fig. 5–104) is the turning device most commonly used in AMEDD hospitals.

IDENTIFICATION OF PARTS

1. *Frame locking bars.* There are four frame locking bars (A, fig. 5–104), two in each head and foot assembly. These bars hold the anterior and posterior frames in place. The top bar is removed at the head and foot to release the top frame after turning. The bottom bar at the head and foot secures the frame on which the patient is lying. You must never pull out the bottom bars when the frame is in use. Mistakes have occurred, and the patient has been dropped to the floor because the person caring for the patient has become confused and pulled out the wrong locking bar.
2. *Safety lock T-handle.* The safety lock T-handle (B, fig. 5–104) at the head of the bed secures the rotating mechanism. The safety lock is released by turning the T-handle until it is loosened. This is done just before the frames are rotated. At all other times, the safety lock T-handle must be tight.
3. *Posterior Frame.* The posterior frame (C, fig. 5–104), on which the patient lies supine, is identified by the straight rod turnbuckle toward the head end of the frame. Two long canvas sections are laced in place, leaving a 4- to 6-inch opening between these two sections for the bedpan. A canvas strap is always buckled in place to keep the buttocks from sagging through the opening; this strap is removed only for times when the patient uses the bedpan or for skin care. Note placement of the bedpan holder in D, figure 5–104. The deep end is always toward the foot; otherwise the bedpan cannot be slipped in place.
4. *Anterior frame.* The anterior frame (E, fig. 5–104), on which the patient lies prone, is identified by the looped turnbuckle toward the head of the frame.

NOTE

The turnbuckles on the posterior and anterior frames are used to adjust the frames for hyperextension. However, unless this feature is ordered by the doctor, the frames are kept straight, and the turnbuckles must never be turned.

Two short canvas sections are laced in place: one extending from just below the shoulder girdle to the symphysis pubis and the other extending from 4 to 6 inches below the pubis to the internal malleoli of the ankles. These two covers must be adjusted to conform to the patient's body structure. Two canvas straps are used on the anterior frame in addition to the covers. The broad strap covers the perineal opening and the narrower strap supports the patient's forehead—it is the headrest.

5. *Traction bar.* The T-shaped traction bar (F, fig. 5–104) at the foot of the bed is used for pelvic and lower-extremity traction. The traction ropes leading to the pulley and weights are attached to this bar.

NOTE

When cervical traction is needed, the traction rope is passed through the rotary mechanism at the head of the bed, and no traction bar is used.

6. *Traction pulley.* A traction pulley (G, fig. 5–104), at the head and foot of the bed receives the rope passed through the rotating mechanisms, which maintain constant traction at the head or foot when the frames are rotated.
7. *Leg lockpins.* Leg lockpins (H, fig. 5–104)

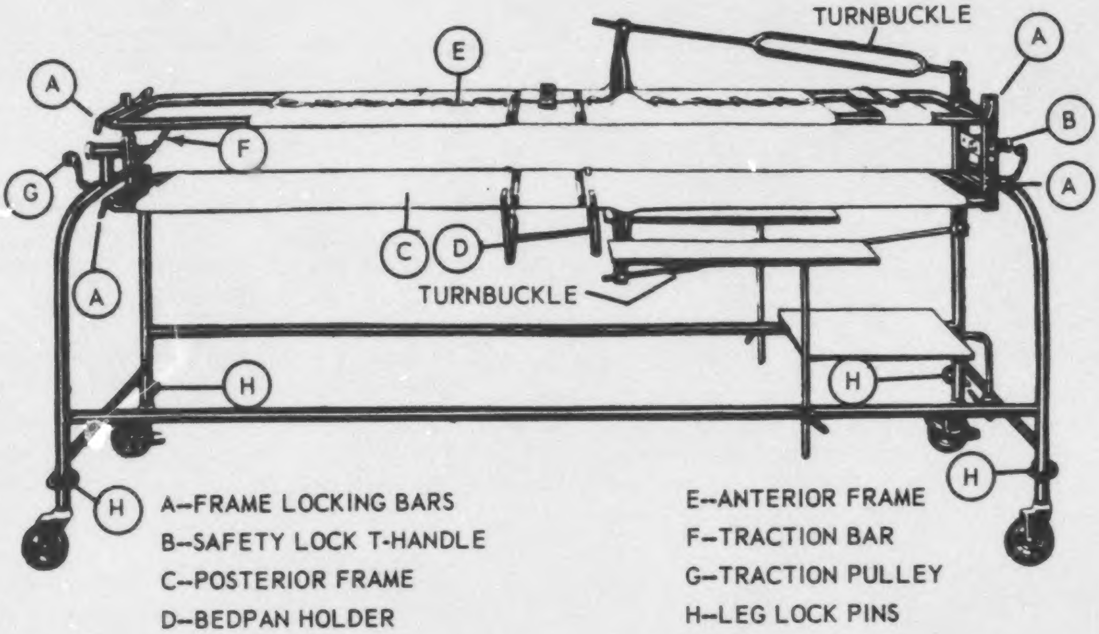


Figure 5–104. Foster reversible orthopedic bed.

secure the legs in extended position when the head or foot of the bed is elevated for countertraction, or when elevation is needed for other purposes.

8. *Accessories.* The arm boards and the utility tray fit into slots and can be swiveled into desired positions, raised, and lowered. A footrest (not illustrated) is also used; it is clamped to the posterior frame at the level required to support the patient's feet at a right angle.

NOTE

When the patient lies prone, if the anterior cover section has been applied to the frame properly, his feet will hang free, perpendicular to the floor. Thus, with proper positioning on either frame, plantar flexion (foot drop) can be prevented. It is important to note that with adjustment of the arm boards, effective support and range of motion of the shoulders and arms can also be provided. (Appendix B illustrates the range of motion of extremities.)

9. *Frame padding.* Foam rubber padding and contoured bedsheets may be available for use on both anterior and posterior frames. In most AMEDD hospitals, bed pillows are substituted for the commercial frame pads and sheets. The use of pillows has several advantages: pillows can be fluffed up and aerated, individual soiled pillows and soiled cases can be changed easily, and no special linen exchange arrangements need be made with the laundry. Four to five pillows for each anterior and posterior frame are required, and one or more pillows for each arm board. The pillows temporarily not in use must be stored neatly at the bedside and reserved for individual use of the patient. Bedside pillow storage can be a problem; one answer is to place boards across the side rails of the base of the frame to form a platform on which the pillows are stacked.

TURNING THE PATIENT ON THE FOSTER BED

The doctor will order the interval between turnings, and turning must take place at the scheduled interval both day and night. The usual policy in AMEDD hospitals specifies:

1. Two persons will assist with each turning, one at the head and one at the foot of the frame.
2. Three restraining straps will normally be used around both frames when the frames are turned, one at the level of the knees, one at the hips, and one at the elbows.
3. No pajamas will be worn by the patient—this allows maximum skin exposure, and no manipulations are needed in putting pajamas on and

taking them off. A loin cloth (hand towel) is draped over the genitalia, and a woman patient also has a towel placed over the breast. Undue exposure must be avoided.

Procedure (Supine to Prone)

1. Tell the patient what is to be done.
2. Lock wheels.
3. Clamp and detach drainage tubes, if in use.

NOTE

If a urinary catheter, use aseptic technique. Place the catheter between the thighs where it will be accessible through the perineal opening of the anterior frame when he has been turned. Place the detached end of the urinary drainage tube in a fold of sterile towel on the utility shelf, making sure the free end is above the drainage bottle to prevent siphonage.

4. Remove the foot support. Lower the arm supports, and swivel them under the frame.
5. Place the patient's arms in extension at his side. If his arms are paralyzed, place his hands slightly under the thighs to prevent dangling off the frame.
6. Remove any covering sheet, with no undue exposure.
7. Place wrinkle-free pillows crosswise on the patient, overlapping edges, from chin to pubis and from below genitalia to ankles.
   a. If foam-padded frames are used, place pillows across the knees to hold legs snugly in place when turning.
   b. If the patient has a tracheotomy, place the first two pillows to form a V-neckline to assure a clear airway.
8. Place the anterior frame over the patient, lowering the head end first so that it is snug but with no undue pressure. Ask the patient how it feels.
   a. Aline the locking slot on the head end of the frame to the appropriate hole in the head assembly.
   b. Slide the locking bar through the hole, the slot, and the hole on the opposite side. Check to see that the hinged end of the locking bar is angled down (toward the floor) when the bar is in place.
   c. Lock the foot end in a similar manner, checking to see that the foot slot is alined to the same hole as the head slot.

NOTE

The assistant at the foot end verifies the slot and hole alinement with the assistant at the head end.

9. Secure restraining straps.
10. Warn the patient that he is about to be turned. The specialist at the head end tells the patient and his assistant the direction of turn ("left" or "right" designates the patient's left or right side).
11. Have the specialist at the head end loosen the T-lock handle and give the signal to the assistant at the foot end. Both turn the frame quickly and smoothly to prone position.

NOTE

When turning the frame must be a 1-man operation, with no assistant available, loosen the T-lock handle while holding the frame steady. Then stand near the head end at the side of the frame and rotate the frame toward you.

12. Have the specialist at the head end reset the T-lock handle. Test the bottom frame by attempting to rock it back and forth. It should be firmly positioned.
13. Remove locking bars from TOP frame.
14. As the bars are removed, slip each one through the loop of the corresponding bottom bar to avoid mislaying one. If a bar is lost, the frame cannot be secured for turning.
15. Remove the top frame, placing it upright against the nearest wall.
16. Remove the pillows on which the patient was lying.
17. Using aseptic technique, reconnect drainage tubing. Release all drainage clamps.
18. Adjust padded perineal strap, making sure there is no constriction of the catheter if one is used.
19. Adjust forehead, arm, and foot supports for comfort and body alinement.
   a. Adjust forehead strap so that there is no pressure on eyes.
   b. Check to make sure there is no pressure on the throat from the top cover of the anterior frame.
   c. Pivot arm rests, elevate them, and adjust pillows on them to support the arms, shoulders, wrists, and hands in a position of function. The arms may be placed in abduction with forearms in flexion, or al-

ternately, in extension. (Appendix B illustrates joint movements of arms and shoulders.)

   d. Elevate the lower legs slightly by placing a small pillow or pad under the shins so that the knees are in slight flexion and the feet hang perpendicular to the floor, with no pressure on the dorsum of the feet.

20. Give the patient back care from the top of the head to the soles of the feet, with special attention to the back of the head, the back edges of the ears, and all bony prominences of the trunk and extremities. Report any evidence of pressure sores immediately.
21. Swivel the utility tray in reach of the patient's hands. He can use the tray when he is in prone position and has use of his arms and hands for many purposes—feeding himself, reading, shaving, tooth brushing, etc. Be sure the tray is clean, dust free and secured by the lockpin.
22. Check posterior frame, making sure the canvas is taut and clean. Replace canvas p.r.n.
23. Replace any soiled pillowcases. Fluff and aerate pillows and stack neatly on a platform made on the bedrails, or on a chair.
24. Store turning straps in designated place—looped to the frame or rolled and placed in the bedside stand. Do not mislay the straps.

Procedure (Prone to Supine)

1. To turn from prone to supine follow procedure for turning from supine to prone, steps 1 through 17, with these exceptions to step 7—
   a. When pillow padding is used, overlap edges from head to heels, arranging an overlap at buttocks level so that space can be made p.r.n. for using bedpan and for cleansing.
   b. Follow local instructions for placement of small pillow or pad at cervical and lumbar areas (fig. 5–105)—remember that when the patient is supine, these two areas may need additional support. Placement of supports before turning will prevent sagging.

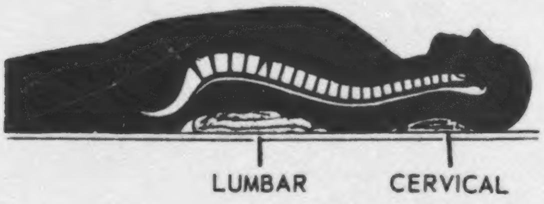


Figure 5–105. Effects of pads to support lumbar and cervical areas.

2. Check body alinement when in supine position.
   a. Adjust buttocks strap so that buttocks do not sag through the bedpan opening.
   b. Check alinement of hips and thighs to avoid either external or internal rotation at the hips. Separate thighs slightly, using towel roll p.r.n. on either side of each thigh for support.
   c. Adjust leg pillows so that the heels are free of pressure.
   d. Place a small pad under the knees to provide slight knee flexion.
   e. Place footrest to support feet at a right angle, separate ankles, using a small pad between ankles and a towel roll or sandbag on either side to prevent inversion or eversion.
   f. Adjust arm boards and pillow supports to provide prescribed range of motion and position of function for shoulders, arms, wrists, and hands.
3. Give skin care with special attention to all bony prominences—clavicles, hip bones, and knees. Note any signs of pressure and report them immediately.
4. Check perineal area. Cleanse genitalia p.r.n. If indwelling catheter is present, check its position and note free drainage in connector.

5–131. Stryker Turning Frame

The Stryker turning frame (fig. 5–106) is commonly used when transporting patients between hospital treatment facilities. It is also used in hospital wards. The turning frame rests on a wheeled cart base. The frame is lifted off the cart when necessary for loading and unloading operations during transportation.

IDENTIFICATION OF PARTS

1. *Cart.* The wheels of the cart (A, fig. 5–106) can be locked and the legs elevated for traction at head or foot. The support runners of the frame are locked in place with a wing-nut bolt so that the frame rests securely on the cart. The utility tray (fig. 5–106) slides on the cart base to the desired place for use.
2. *Locking pin.* Two round locking pins (B, fig. 5–106) at the head and at the foot of the Stryker frame release the rotating mechanism.

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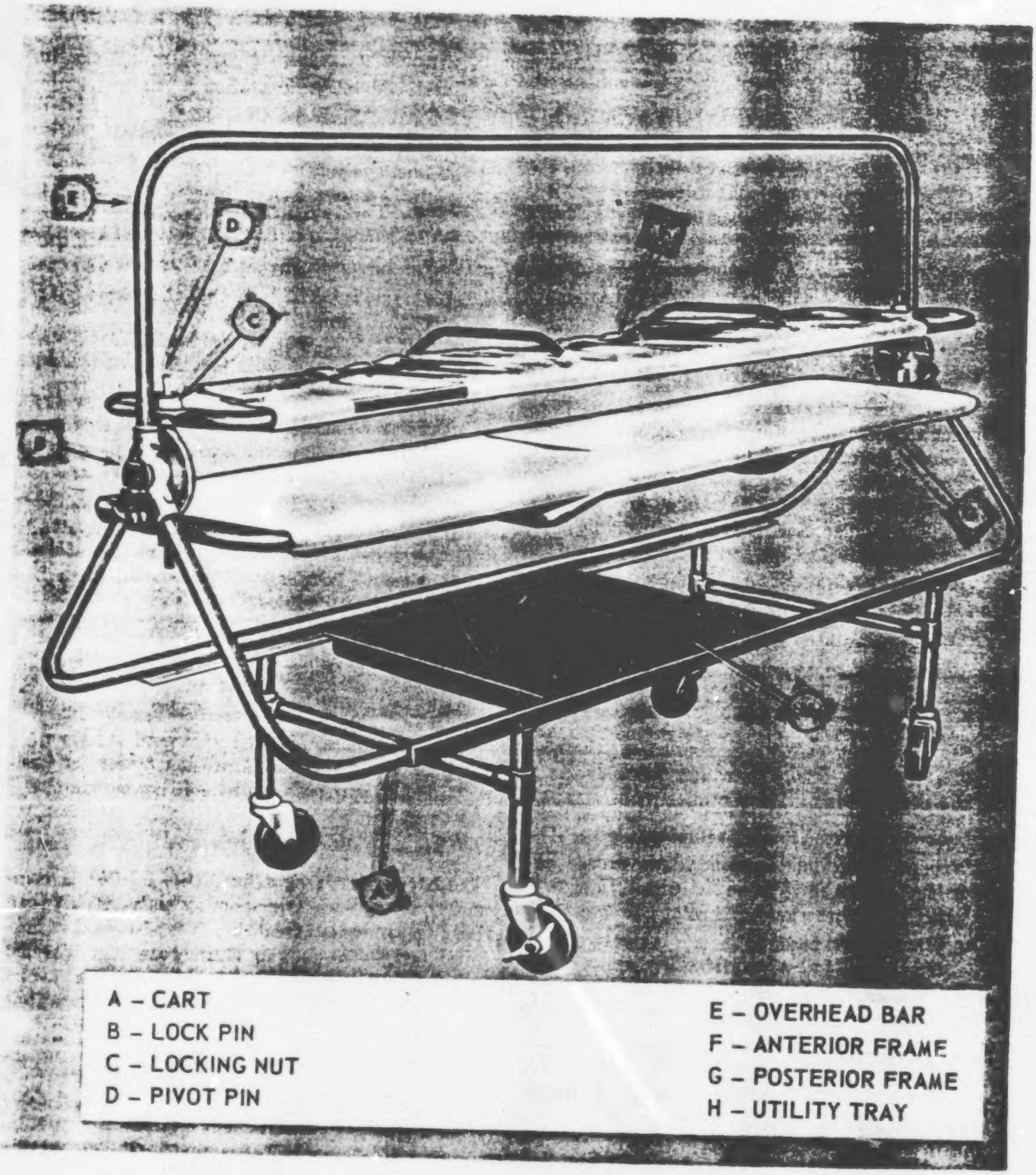
E
D
C
F
H
G
A
A – CART
B – LOCK PIN
C – LOCKING NUT
D – PIVOT PIN
E – OVERHEAD BAR
F – ANTERIOR FRAME
G – POSTERIOR FRAME
H – UTILITY TRAY

Figure 5–106. Stryker turning frame.

Pull them out for turning; they will re-engage automatically when the frame is turned. Always check to see that both ends are locked by rocking the frame slightly. Do not use the frame if the locking pin cannot be re-engaged.

3. *Locking nuts.* Four round, knurled, screw nuts (C, fig. 5–106) fit onto the 4 pivot pins (D, fig. 5–106) of the head and foot turning assembly. When in use, the locking nuts hold the anterior and posterior frames together for turning and

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secure the frame on the pivot pins. If a nut is lost or misplaced, the frame cannot be used.

CAUTION

> When you remove a locking nut, hold it in your hand and, as soon as the frame is lifted off the patient, replace the nut on the pivot pin.

4. *Overhead bar.* This bar (E, fig. 5-106) is detachable and is removed when the patient is first lifted onto the frame. It can be used to drape top covers as with a bed cradle. A patient who is permitted to lift himself can also grasp the bar as he would a trapeze.
5. *Anterior frame.* This is the frame (F, fig. 5-106) on which the patient lies face down. It is fitted with a 1-piece canvas cover that has a round perineal opening. The length of the anterior canvas is adjusted on the frame to conform to the patient's dimensions: from shoulder girdle to perineal opening and from perineal opening to internal malleoli of the ankles. The canvas is kept taut by hooks and tension straps. A face piece (not illustrated) or a canvas strap is used on the anterior frame for a headrest.
6. *Posterior frame* (G, fig. 5-106). This is the frame on which the patient lies face up. It is fitted with a 2-piece canvas cover and a canvas buttocks strap.
7. *Accessories* (not illustrated). Arm boards fit into slots on the runners and cart base, and a footrest clamps to the posterior frame. Foam rubber padding and contoured sheets may be available, or pillow padding may be used as with the Foster reversible bed.

PROCEDURE FOR OPERATING THE STRYKER FRAME

Follow procedure as for the Foster reversible bed (para 5-130) with these exceptions—

1. The operators at the head and the foot of the frame remove the top knurled locking nut from the head and the foot pivot pins. Each operator holds the locking nut in his hand until it is replaced on the pivot pin.
2. The frame to which the patient is to be turned is placed over the patient, fitting the holes at the head and the foot of the frame on the pivot pins.
3. The knurled locking nuts are screwed on the pivot pins, securing first the head end and then the foot end.
4. The restraining straps are fastened and the patient and assistant are instructed on the direction of the move.
5. The locking pins at the head and at the foot of the frame are pulled out and the frame rocked slightly to make sure both are disengaged.
6. The patient is turned. The locking pins should both snap back into place when the turn is completed. Frame can be tested by attempting to rock it slightly.
7. The straps are unfastened and removed from the top frame by unscrewing the TOP knurled locking nuts at the head and foot. Nuts on the pivot pins are replaced immediately.

5-132. Improvised Field Litter Frames
(fig. 5-107)

a. Anterior Frame. This is the frame on which the patient lies face down. Two holes are cut in the canvas—one for the face and a small central one for a urinary catheter drainage tube. Folded blankets are used to pad the litter. Holes punched in the blanket are laced with bandage on the underside to provide a smooth, firm, wrinkle free surface. Holes corresponding to the litter face and catheter holes are cut in the blanket and the openings are heavily taped for reinforcement. ABD pads secured around the holes provide extra comfort and protection.

IMPORTANT NOTE

> Holes must correspond to the face and genitalia of the patient for whom the frames are prepared.

b. Posterior Frame. This is the frame on which the patient lies face up. One hole for use of a bedpan may be cut in the litter. When this is done, the canvas must be heavily taped for reinforcement to avoid tearing from the weight of the body. The blanket padding also has only one hole cut for the bedpan, and a thickly padded strap must be available for use to keep the buttocks from sagging through the opening when the bedpan is not in use.

c. Footboard. A padded right-angle footboard must be used when the patient is supine, to support the feet in neutral position. Any available box of suitable size is an appropriate footboard.

d. Turning Straps. Two webbed straps are used to hold the two frames together when turned. The turning straps are placed at the knees and at the chest.

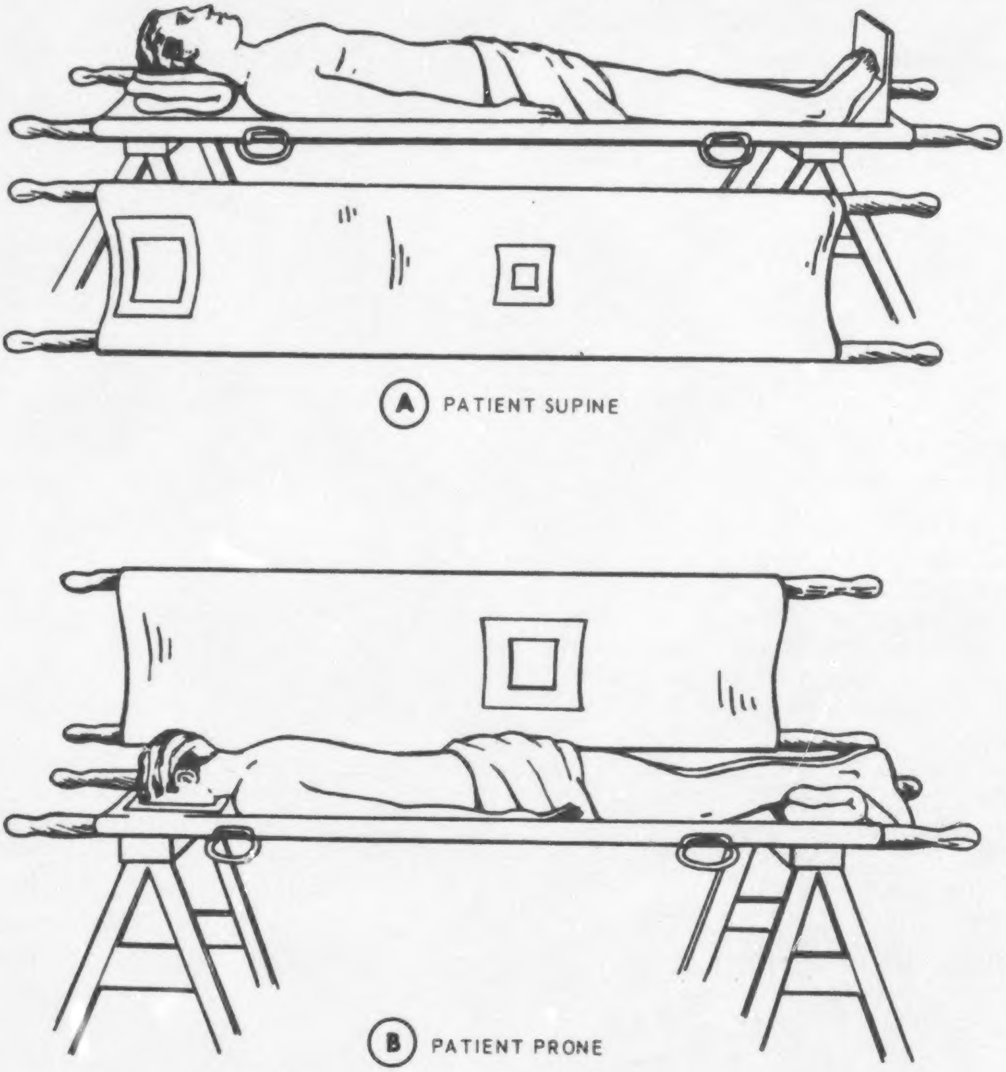


Figure 5-107. Improvised field litter frames.

TO TRANSFER THE PATIENT TO THE LITTER FRAME

1. Keep the patient supine on the original litter on which he has been transported to the medical treatment facility—do not attempt to move the patient from this litter until the improvised turning frame has been prepared.
2. Elevate the litter (with the patient lying on it) on a pair of sturdy boxes—one at the head and one at the foot of the litter—or on a pair of sawhorses. The boxes or sawhorses provide steadier base than the field litter brackets.
3. While the patient is supine, slit all clothing along seams and expose the anterior body surface. Use a towel drape over genitalia.
4. Place the patient's arms in extension, with fingers slightly under each thigh. If pillows are available, place two of them crosswise over his legs from knees to ankles. If pillows are not available, use extra folded blankets. This leg padding keeps the limbs from sliding when the frame is turned.
5. Place the prepared anterior frame gently over the patient, alining face and perineal opening to the patient.
6. Strap the anterior frame and the original transport litter together, sandwiching the patient between them. Apply the straps snugly and securely at chest and knee level.
7. Tell the patient that you intend to turn him so

that he will be face down on the padded litter frame.

TURNING

1. Both operators must be in agreement on the placement of their hands in order to coordinate the turn. Both must understand that the operator at the head of the frame will give instructions and that the turn to left or right is in accordance with the head operator's left or right.
2. Both operators cross hands and place the top hand on the same side of the top litter and place the bottom hand on the same side of the bottom litter. The hand on top is the direction of turn.
3. With hands in position, palm up, both operators grasp the litter handles firmly. On signal, both lift, turn, and lower the frame back onto the frame support.

CAUTION

Be sure the patient's face is not lowered onto the support; the head operator must check for this.

4. With the turned frame securely resting on the supports, remove turning straps. Lift off the unpadded litter. The prepared padded litter (posterior frame) will be used in all subsequent turns.
5. Remove all clothing by lifting it off the patient, slitting it along seams when necessary to avoid unnecessary movement of the patient.
6. With the patient prone and his back fully exposed, make initial examination of the patient's posterior body surface.

Routine Positioning

Whether prone or supine, the patient must be positioned so that arms, hands, legs, and feet are in a position of function.

- *Arm position.* Position arms at sides in extension, or alternately, in abduction, with forearms in flexion and hands at shoulder level or slightly above the shoulders. The hands and wrists may be supported in a position of function by placing a bandage roll in each palm and curling the fingers and thumb around the roll to grasp it.
- *Leg position.* Prevent internal or external rotation at the hips by rolled blankets placed parallel to thighs and between legs from groin to ankles. Separate ankles with folded towel pads. When supine, place a small pad under the Achilles tendon to elevate the heels and a small pad just distal to the popliteal space to keep the knees in slight flexion. With the padded right-angle footboard in place, keep both feet in neutral position (toes pointing upward). When prone, place a folded blanket or small pillow, if available, beneath the lower legs to keep the knees in slight flexion and the feet hanging free and perpendicular to the floor. There should be no pressure on the dorsum of the feet or on the toes.

Routine Turning

1. Schedule turning q.2 h., day and night.
2. Using aseptic technique, disconnect the urinary drainage catheter if one is in use, placing the clamped catheter between the thighs for immediate accessibility through the perineal opening.
3. Remove footrest, supporting pads, and blanket rolls.
4. Place arms in extension with fingers slightly under thighs.
5. Pad lower legs with blankets or pillows.
6. Aline top frame openings to the patient.
7. Secure turning straps at chest and knee.
8. Tell the patient to which side he is being turned.
9. Turn the patient. Remember, with hands crossed, the top hand is direction of turn.
10. When the patient is turned—
    a. Using aseptic technique, reconnect catheter if in use.
    b. Check alinement and position of all extremities.
    c. Give skin care, from top of head to heels.

CAUTION

Use gentle circular movements in bathing and massaging bony prominences and pressure points. Report any evidence of pressure immediately.

11. Check all frame openings for any pressure on body areas, constriction of body tissue, or constriction of tubing.
12. Check for firm, snug placement of buttocks strap when in supine position to avoid any sagging of the body through the bedpan opening.

NOTE

Place the bedpan on a box beneath the bedpan opening when one is used.

NOTE: PAGE 164 HAS BEEN DELETED; HOWEVER ALL MATERIAL HAS BEEN INCLUDED.

Section V. MINOR SURGERY

6–31. Assisting With Minor Operative Procedures

a. General. A minor operative procedure usually involves an incision but does not necessitate exposure of viscera or large areas of internal body tissue; it is usually a procedure of short duration that is often performed with administration of a local rather than a general anesthetic. When the patient's needs before, during, and after the operative procedure can be met on an outpatient basis, the minor operative procedure may be performed in an appropriately staffed and equipped dispensary. The medical officer who examines the patient and evaluates his condition makes the decision; if the patient's needs cannot be met, he is referred to a hospital for treatment as an inpatient. Examples of minor operative procedures customarily performed in a dispensary or outpatient surgical clinic or emergency room include primary closure of selected superficial incised or lacerated wounds; removal of superficial foreign bodies or small superficial tumors; and incision and drainage (I and D) of an abscess such as a furuncle or paronychia (abscess underlying a nailbed or nail margin). Surgical techniques involved include wound preparation for debridement, suturing, incision, excision, and drainage procedures.

b. Role of the Medical Specialist. The medical specialist is expected to function as the medical officer's nonsterile assistant—as a circulator. (There will be occasions, however, when the surgeon will require a sterile (scrubbed) assistant as well as a circulator; *for example,* to assist with wound preparation for debridement.) The circulator will be directly involved with organization and coordination of activities associated with preoperative patient care, preparation and arrangement of supplies and equipment, assisting the surgeon in a nonsterile (unscrubbed) capacity, and assisting with immediate postoperative patient care. His primary responsibilities are the maintenance of asepsis, anticipation of the surgeon's needs, and safety and comfort of the patient. A basic rule for the circulator is: do not leave the room once the operative procedure has started unless sent out by the surgeon, as he depends upon the circulator's presence to make it possible for him to maintain sterile techniques and to concentrate on the patient and the operative procedure.

c. Routine Duties. In general, routine duties should be organized in a sequence that avoids undue delay and omission of important details. The following outline can serve as a general guide, subject to variations applicable to the local situation. The outline is an adaptation of basic routines discussed in greater detail in TM 8-220. In the dispensary situation, the surgical team is usually composed of only two members—the surgeon, who scrubs and is the sterile member of the team and is both surgeon and anesthetist, and the medical specialist, who as circulator is the nonsterile surgical assistant and room activity coordinator.

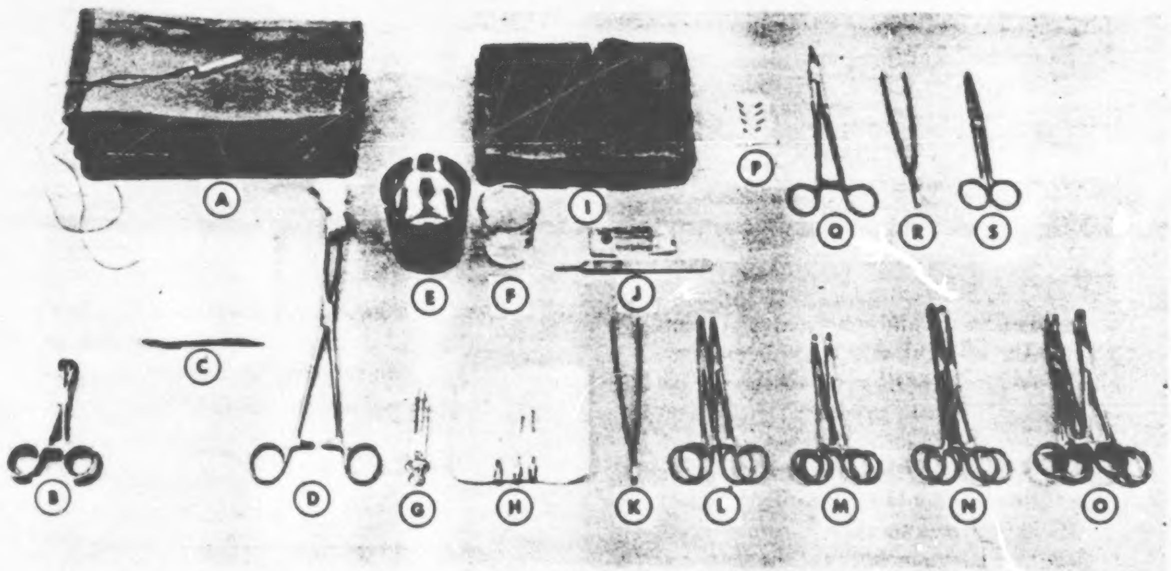
PRELIMINARY DUTIES

1. Check with the surgeon for instructions concerning patient preparation and supplies and equipment required. A locally prepared SOP may be followed, subject to change to meet individual patient needs. Find out if an operative permit, when required, has been signed and included in the Health Record.
2. Tell the patient what is to be done and what he can do to help. Remember, even though he may be outwardly calm and apparently unconcerned, he needs reassurance and support. When possible, escort him to a waiting area apart from other waiting patients but put him where he can be observed.
3. Administer, or verify the administration by another individual, of any prescribed medication. When preoperative sedative, analgesic, or antibiotic drug is ordered, adequate time must elapse for the desired systemic effect; delay in administration will cause undue delay in the start of the scheduled procedure. A booster dose of tetanus toxoid may be prescribed in case of traumatic injury. When required, the surgeon may indicate that it is to precede or follow operative care.
4. Make certain the operating room and its contents are free of dust and of any accumulated waste or debris from previous use. In addition to routine daily cleaning, interim cleaning of floor and equipment may be necessary.

CAUTION

Never dry dust or sweep. When cleaning the floor, use a clean mop head and fresh germicide solution; when dusting equipment and fixtures, use a clean cloth dampened with alcohol, 70 percent.

5. Wash hands. Put on cap and mask.
6. Make certain that equipment normally available for emergency use is accessible and in operating order before the start of any operative procedure. Such equipment includes resuscitator apparatus, oxygen supply, suction apparatus, emergency drug tray, lights (standard and auxiliary battery-powered equipment), and signal light or buzzer for summoning help.
7. Assemble presterilized packs and trays and other supplies and equipment required for the procedure. These materials will usually include the following:
   a. Minor surgery tray (fig. 6-7).
   b. Local anesthetic agent, as prescribed.
   c. Skin antiseptic, as prescribed.
   d. Sterile glove pack.
   e. Sterile brush pack.
   f. Sterile towel pack.
   g. Specimen container for tissue or drainage specimen p.r.n.
   h. Cap and mask (for surgeon).
8. Arrange furniture and equipment for accessibility and convenience in use, taking into consideration the position the surgeon will assume in relation to the patient (right, left, head, or foot of operating table). Place such things as portable instrument stand, stool, waste bucket, suction, and floorlamp accordingly.



USES: TO REPAIR A SURGICAL LACERATION; TO OBTAIN A SPECIMEN OF MUSCLE TISSUE FOR DIAGNOSTIC PURPOSES; TO INCISE A LESION TO PERMIT DRAINAGE.

Ⓐ FOUR TOWELS
Ⓑ FOUR TOWEL CLIPS
Ⓒ SPONGES
Ⓓ SPONGE FORCEPS WITH SPONGE
Ⓔ SOLUTION CUP
Ⓕ MEDICINE GLASS
Ⓖ SYRINGE, 2 CC. (ML.)
Ⓗ NEEDLES: 25 G., 5/8-INCH; 22 G., 1 1/2-INCH; 18 G., 1 1/2-INCH
Ⓘ DRAPE SHEET
Ⓙ KNIFE HANDLE NO 3 WITH NO 15 BLADE
Ⓚ TISSUE FORCEPS
Ⓛ TWO STRAIGHT MOSQUITO FORCEPS
Ⓜ TWO CURVED MOSQUITO FORCEPS
Ⓝ TWO ALLIS FORCEPS
Ⓞ FOUR CURVED HEMOSTATS, SMALL
Ⓟ SUTURE NEEDLES
Ⓠ NEEDLE HOLDER
Ⓡ DRESSING FORCEPS
Ⓢ SUTURE SCISSORS

TRAY SIZE: 15 1/2 BY 9 1/2 BY 2 INCHES

WRAPPER SIZE: 36 BY 36 INCHES

STERILIZATION INDICATOR

NOTE: A PACKET OF STERILE BLACK SILK OR NYLON SUTURE MUST ACCOMPANY THE TRAY. WHEN THE TRAY IS TO BE USED FOR OBTAINING A SPECIMEN, A CULTURE TUBE AND A SPECIMEN JAR MUST ALSO ACCOMPANY THE TRAY.

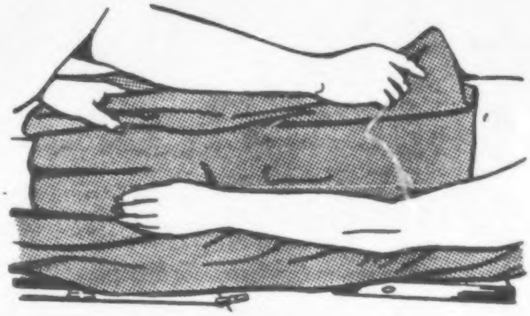
Figure 6–7. Minor surgery tray.

9. Place unopened sterile packs and trays in readiness for use, to be opened just before start of the procedure. Handle all sterile equipment in accordance with basic rules discussed in paragraph 5–47, this manual.
10. When all is in readiness, notify the surgeon. Take Health Record to OR.
11. Escort the patient into the room and assist him onto the table.

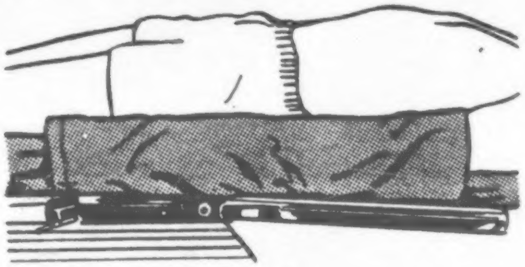
NOTE

Except in an acute emergency, preliminary treatment and physical examination of the patient will have been completed outside the OR area. Check record to insure that all preoperative orders have been carried out. If vital signs have not been recorded, take and record pulse, respiration, and blood pressure. If any unusual signs or symptoms are observed, notify the surgeon so that he can examine the patient and evaluate the condition before he starts to scrub.

12. Position the patient on the table in accordance with instructions, maintaining good body alinement and protecting the patient from contact with any unpadded table surface. The position is usually dorsal recumbent, with the knees directly over the hinged-table break. Expose the affected area. If an arm board is required, place a well-padded, 12-inch wide, arm support level with the table, and position the patient's arm and hand on the padded surface. Restrain the unaffected arm by securing it in the lift sheet (fig. 6–8). Securing the arms in this fashion helps the patient to control inadvertent movements that would interfere with the surgeon's procedure. A thigh strap for support and restraint should be used if that portion of the body is uninvolved in the procedure. Whenever the patient has received a preoperative sedative medication, restraint is mandatory. If an arm board is not required, place both arms in extension at sides and secure both in the lift sheet. A very large patient may require arm boards on both sides of the table for arm supports if the table is too narrow to support the patient's arms and body.
13. Cover the uninvolved body area with a clean sheet.
14. Wash hands.



STEP 1.
PLACE THE ARMS AND HANDS AT THE SIDES. THE ELBOWS SHOULD BE FLEXED SLIGHTLY AND THE FINGERS EXTENDED AND SLIGHTLY SEPARATED.



STEP 2.
SECURE THE ARMS AND HANDS WITH THE LEFT SHEET, ANCHORING THE SHEET UNDER THE TABLE PAD.

Figure 6–8. Dorsal recumbent position with arms secured in OR table lift sheet.

15. Open outer wrappers of sterile brush, towel, and glove packs. Open outer wrapper of sterile instrument tray, leaving interior wrapper and contents untouched. Once he is scrubbed and gloved, the surgeon handles the sterile surface of the wrapper and the tray contents.

DUTIES DURING OPERATIVE PROCEDURE

1. Move the instrument table p.r.n., handling it by grasping underneath and reaching below and outside the limits of the sterile field.
2. Adjust ceiling and floor lights p.r.n., focusing the light so that shadow-free illumination is concentrated on the operative area.
3. Pour solutions as required for final skin and wound preparation. This preparation is always done by the surgeon (or his scrubbed assistant). Replenish sponge supplies p.r.n., using transfer forceps. Hold and support the patient as directed while the prep is done, using utmost care to avoid contact with the surgeon's gloved hand.

4. Assist as directed with draping. Draping for minor procedures is minimal and is usually accomplished with the four towels, four towel clips, and one small fenestrated (windowed) sheet on the presterilized tray. In assisting with draping, avoid all contact with the surgeon's gloves, the sterile surface of the drape, and the cleansed skin area.

5. Assist as directed with administration of local anesthetic. When the surgeon uses an infiltration technique with syringe and needle, it is done after skin preparation and draping.
   a. Check the vital label. Unless otherwise instructed, always provide the prescribed anesthetic in a vial with the seal intact. Hold the vial so that the surgeon can read the label and observe the solution for clarity. The surgeon verifies that the drug is the one prescribed, is in the desired strength, and is uncontaminated.
   b. If vial contents are to be poured into a sterile container on the tray, remove the metal seal. Using a sterile hemostat, lift the rubber stopper without contaminating the lip of the vial. To avoid reaching over the sterile field, request the surgeon to hold the glass. Verify the label again before pouring.
   c. If the surgeon is to withdraw the solution with syringe and needle, remove the metal seal, avoid contact with the inner surface and any contact with the rubber stopper, which is sterile. Next place your index and middle finger across the shoulder of the vial, support bottom of vial with your thumb, and tilt vial downward with the stopper at an angle that permits the surgeon to insert the needle and withdraw the required amount of solution.
   d. Stand by and stay alert while the surgeon injects the anesthetic solutions. He will usually first use the smallest needle on the tray to make a skin wheal and then will substitute a longer needle to infiltrate the deeper skin areas for anelgesia. Inform surgeon when he has used 50 ml. of the local anesthetic. Note the time when anesthesia began—the time of the initial injection—and record this time. The surgeon allows several minutes to elapse before proceeding with the operative procedure. During this time, he observes the patient for any untoward reaction and depends upon you to assist if an emergency should arise. Do nothing to distract the surgeon's observations. Keep unauthorized personnel from entering the area. Be ready to supply emergency treatment items stat., such as oxygen, suction, and epinephrine solution for injection from the emergency drug tray.

6. Assist p.r.n. as the operative procedure continues.
   a. Keep room and work area neat by removing articles inadvertently dropped on floor. Use unsterile forceps (not bare hands) to handle soiled sponges or other materials soiled with body fluids.
   b. Make notations in memorandum form for preparation of required reports. For example, keep a record of time: time anesthesia started is the time of initial skin injection; time operative procedure started is the time of the initial incision; time operation is completed is the time of placement of the last suture.

7. Receive and process specimen for laboratory examination. Unless otherwise instructed, handle all tissue specimens as follows:
   a. Have ready a specimen jar (with lid) half-filled with 10-percent formalin solution. However, if specimen is to be photographed, do not place in formalin because it discolors tissue. Receive such a specimen in a CRS basin and cover with a towel or gauze sponge moistened with normal saline solution.
   b. Hold container so that the surgeon may drop tissue specimen directly into container.
   c. Verify the kind of tissue by asking the surgeon what it is. Make no assumptions.
   d. Place the lid on the container.
   e. Process multiple specimens from the same patient by receiving each in a separate container and marking each label No. 1, No. 2, and so on. Verify the kind of tissue in each.
   f. Prepare a label for each specimen. Write on each label the date of operation, the patient's name (last, first, middle initial), unit or home address, rank, telephone number (work or home), the clinic or dispensary, the surgeon's name, and the kind of specimen.
   g. Use the same laboratory form (SF 515)

for all specimens, recording the number and kind of each specimen on the form.

- h. Place specimen in designated place for transfer to laboratory.
- i. Hand-carry specimen to laboratory at the end of the operative procedure. Give it to a laboratory technician.

NOTE

Take all tissue specimens to the pathology section of the laboratory.

8. Assist with application of dressing.
9. If you are relieved during the operative procedure by another individual, tell him what is taking place before leaving the room.

DUTIES AFTER OPERATIVE PROCEDURE

1. Check to be sure that all such items as towel clips and needles are removed before handling linen. Remove linen towels, drapes, etc., from the patient.
2. Assist in moving the patient from the table.
3. Escort the patient out of the room. He may walk or he may require litter or wheechair assistance.
4. Stay with the patient until relieved by the individual responsible for followup care.
5. Clean the room in preparation for the next case or for the next emergency.
    - a. Clear the suction tubing and disconnect suction.
    - b. Empty and wash suction bottle.
    - c. Empty and wash waste bucket.
    - d. Wet mop floor.
    - e. Rearrange furniture.
    - f. Replenish supplies.
    - g. Place clean linen on table. Cover pad with a sheet doubled lengthwise and secured with envelope corners at head and foot (fig. 5–5). Place a lift sheet across the center, folding a sheet in quarters crosswise and fanfolding the ends to keep them from dangling over the sides of the table.
    - h. Clean and return any special equipment to its proper storage place.
    - i. Report any defective equipment. Label and remove it from the room.
6. Care for the instruments according to local CMS directive.

NOTE

Use great care to avoid self-injury when handling knife blades and needles. Handle with forceps and, unless otherwise directed, discard, in labeled "sharps" waste container.

7. Prepare report forms required for surgeon's completion if he completes the required report in handwriting. (If he dictates the report, prepare a memorandum to give to him. The memorandum includes identification of the patient.) The report forms include:
    - a. SF 516—Clinical Record, Operation Report.
    - b. SF 517—Clinical Record, Anesthesia Report.
    - c. SF 515—Clinical Record, Tissue Examination.

6–32. Surgical Scrub and Glove Technique

a. General. When a medical specialist serves as a sterile assistant, a surgical scrub and glove technique is employed to eliminate, in part, controllable factors of contamination of the operative (sterile) field. Since a minimal sterile instrument and sterile drape setup is used in minor operative procedures performed in a dispensary operative facility, it is customary to perform a surgical hand scrub, put on sterile gloves, and omit wearing a sterile gown. Contact with the operative field must then be limited to the sterile gloved hands. The individual is working within a narrow margin of safety and must be exacting and precise in all movements to prevent contamination.

b. Purpose of Surgical Scrub and Gloving Procedure. Hand washing is an important asepsis factor in all patient care areas. Bacteria normally present on the skin must be reduced in number by mechanical friction, chemical applications (as with soap), and rinsing with water. These measures are essential for routine handwashing and, when properly done, will remove many bacteria classed as transient—bacteria introduced onto the skin surface by contact with soil and various other objects. Another class of bacteria, resident bacteria, are those found under the fingernails and in the deeper layers of the skin, in hair follicles, and in openings of sebaceous glands. In addition to routine handwashing, scrubbing is necessary to remove resident bacteria from the surface and just beneath the surface. However, after a time, the bacteria in deeper layers are brought to the surface of the skin by perspiration, and the bacterial count on the previously scrubbed skin surface is again very high. For this reason, sterile gloves are worn when hands must handle various sterile articles, wounds, and various body tissues. Because there is always a possibility of gloves being torn or punctured, having the underlying skin surgically clean provides a margin of safety when accidental damage to sterile gloves occurs. When such accidents do occur, the gloves must be changed immediately. Furthermore, the instrument, article, or body tissue area touched by the damaged glove is considered contaminated. Inanimate articles must be discarded. The body tissue area touched must be reported to the surgeon so that he will know how and when contamination occurred. Any measure taken in handling contaminated tissue is in accordance with the surgeon's order.

c. Scrub Procedure. Procedures and times for scrubbing may vary slightly. The only adequate manner in which the effectiveness of a scrub procedure can be determined is by periodic cultures taken from the hands and arms of personnel. A recommended procedure is a 10-minute surgical scrub with a standard antibacterial liquid detergent (surgical soap with hexachlorophene). Follow local directives for any variations.

(1) *Personal preparation.* The individual scrubbing must be personally clean; wear clean clothing; be free of any infection about the hands, nails, and arms; and free of any sign of a cold or other upper respiratory ailment.

(2) *Individual preparation.*

(*a*) *Fingernails.* Fingernails must be short —not visible over the tips of the fingers. Short nails permit easy cleaning and reduce the possibility of puncturing gloves. Nail polish must be removed.

(*b*) *Jewelry.* All jewelry is removed from hands and arms. A wedding band is jewelry and must be removed. It can be pinned to the pocket of the scrubsuit to prevent loss, but it must be removed from the finger.

(*c*) *Clothing.* A clean, short-sleeved, cotton scrub suit or dress is desirable. Street clothes or uniforms worn in other patient care areas should not be worn when scrubbed.

(*d*) *Cap or turban.* A clean cap, discarded daily, is worn so as to cover the hair completely. Wearing the cap or turban prevents possible contamination of the sterile field by falling hair or dandruff.

(*e*) *Mask.* The surgical mask, made of 6-layered gauze or a special, molded, plastic material, must fit snugly around the nose and mouth. Air must filter through the mask, not leak around the sides. Ideally, the mask should be worn no longer than 30 minutes or changed as soon as it becomes damp. After it becomes damp, droplets from the nose and mouth can pass through it easily. Careful handling of the soiled mask prevents the spread of organisms. It must be handled by strings only and placed in a designated receptacle; then the hands must be washed. It must never be allowed to dangle around the neck nor placed in a pocket after removal.

(3) *Surgical scrub area.* The scrub area in a dispensary is usually a scrub sink in the treatment room, unlike the separate scrub room in an OR. However, certain equipment is necessary— faucets controlled by a foot, knee, or arm lever; surgical soap dispenser with foot control; and an adjacent high shelf (above elbow level) or adjustable stand on which sterile brush, towel, and glove packages are to be placed. A clock with a second hand must be provided for timing the scrub procedure. The scrub sink area should be arranged so that the danger of contamination is lessened and splashing is eliminated as much as possible.

(4) *Scrub procedure—general rules.* Whether an operative procedure is classified as major or minor, a complete 10-minute scrub is performed when a surgical hand scrub is required. A complete scrub is also done if gloves have been punctured during the procedure. The method of timing the scrub must be such that every involved anatomical area—nails and skin surfaces of hands and arms, to well above the elbows—receives a definite number of brush strokes. A definite pattern of strokes should be followed, as each finger, then the hand, and then the arm is scrubbed, so that no area is inadvertently omitted. A recommended scrub method is illustrated and discussed in paragraph 6–33. Points which apply to the scrub procedure in general are—

(*a*) Preliminary washing time and any rinsing time must not be included in the total scrub time.

(*b*) Once the procedure is started unsterile objects should not be touched.

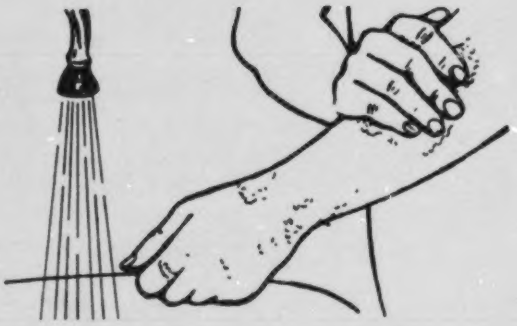
(*c*) If an unsterile object is touched the entire scrub procedure must be repeated.

6–33. Surgical Scrub and Gloving Procedure

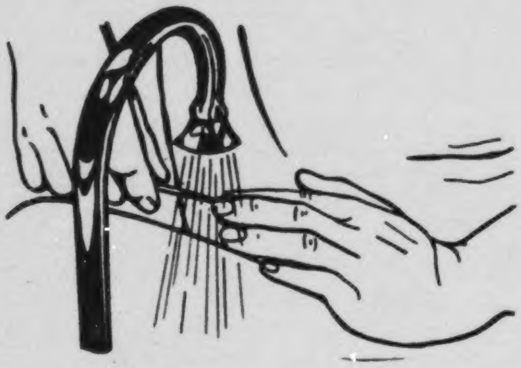
a. After complying with the requirements for personal and individual preparation outlined in paragraph 6–32, follow these steps:

Step 1. If not already done by the circulator, open the outer wrapper of the following individual packages, using aseptic technique: brush package (containing 2 brushes and 2 files or orangewood sticks), towel package (2 towels), and glove package.

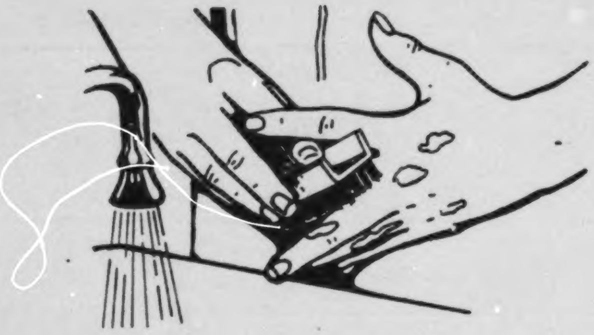
Step 2. Regulate the flow and temperature of water. Wet hands and arms. Using several drops of surgical soap, wash hands and arms to a point about 3 inches above the elbows. Rinse hands and arms thoroughly, allowing the water to run from hands to elbows. Allow water to drop off; do not shake.



Step 3. Pick up file. Clean subungual (under nails) spaces of both hands under running water. Discard file.

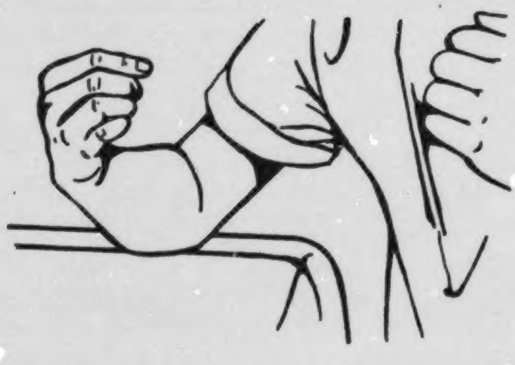


Step 4. Pick up brush, touching only the back and not the bristles. Apply several drops of detergent to wet bristles. Start timing of scrub. Scrub in a definite pattern—start at thumb, then each finger, palm of hand, back of hand, and arm; consider each part as a 4-sided object. Add water and detergent to maintain good lather. Scrub each hand and arm with brush No. 1 for 2 minutes (total time—4 minutes).



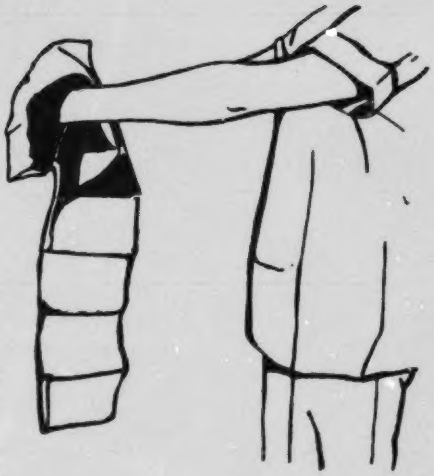
Step 5. Discard brush. Rinse hands and arms, allowing water to run from fingertips to elbows.

Step 6. Pick up second file. Clean fingernails under running water as in step 3. Discard file. Pick up second brush. Using several drops of detergent, repeat scrub as in step 4. Scrub each hand and arm with brush No. 2 for 3 minutes (total time—6 minutes). Spend 1 minute on nails of each hand and 2 minutes on each hand and arm. Rinse as in step 5.

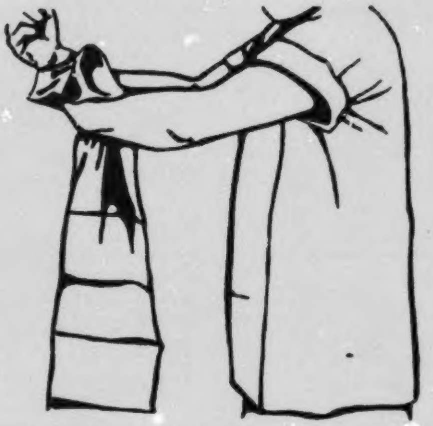


Step 7. After rinsing, keep hands and arms up, above the waist and away from the body.

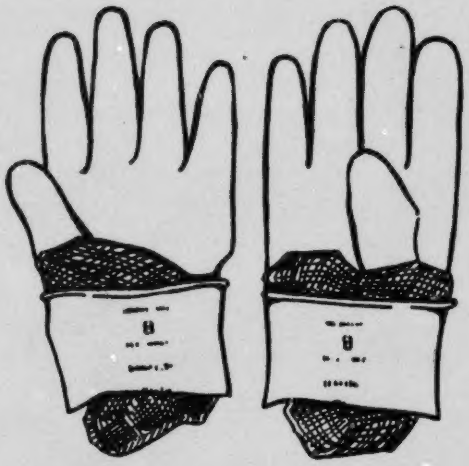
Step 8. Pick up the folded sterile towel and hold at arm's length from your body. Grasp one top corner and allow the towel to unfold to its full length. Do not allow it to touch any unsterile object or your body.



Step 9. Supporting the towel by placing one end over one hand, dry the other hand and arm. Use a blotting rotation motion. Work from hand to elbow. Do not retrace any area. Grasp other end of towel and dry other hand and arm. Use second towel if necessary. Discard towel by dropping from upraised hand into receptacle.



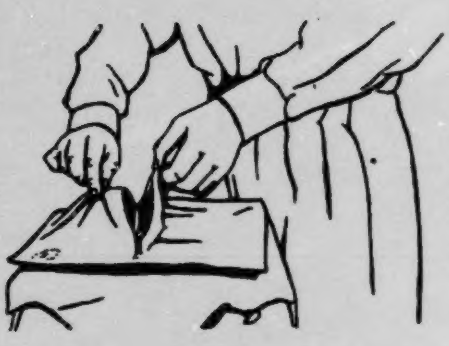
Step 10. Powder hands, using powder packet in glove envelope or glove cream from sterile, peel-back wrap provided by the circulator. Open sterile packet and put contents in one hand. Drop empty packet into waste container. Rub the powder or cream between fingers and over hand surfaces.



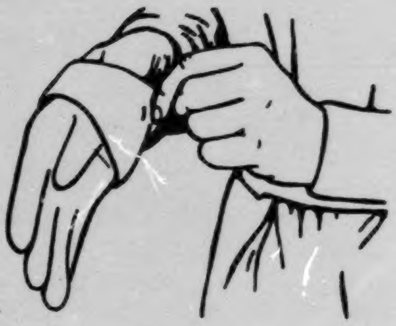
NOTE

In the illustrations for gloving, a gown is worn but the same technique is used when scrubbed but not gowned. Also, the glove pack envelope illustrated here shows how one glove in each fold is packed palms up, thumbs to outer fold corresponding to the user's right and left hand. The packaging permits removal without contamination of the outer surface of the glove—all contact with the bare hand is on the inner glove surface. The glove pack in the illustration represents gloves prepared for sterilization by steam under pressure; the gauze inserts are to separate surfaces to insure steam contact. Gloves packaged for sterilization by ethylene oxide gas do not require the gauze inserts. Either type may be available.

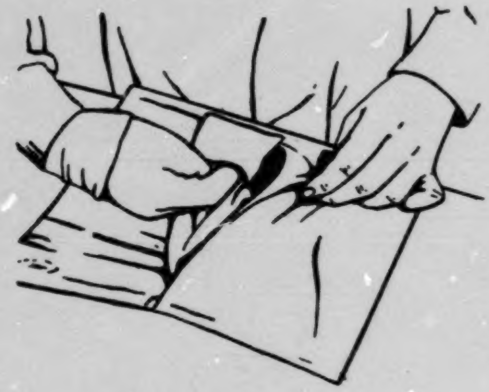
Step 11. Pinch up the flap of the envelope containing the right glove with the right hand. Grasp the glove by the folded edge of the turned-down cuff and remove with the left hand. Do not touch the other side of the envelope. Remove gauze inserts, if present, and discard without touching outer side of glove with bare hands. (If left handed, put on left glove first.)



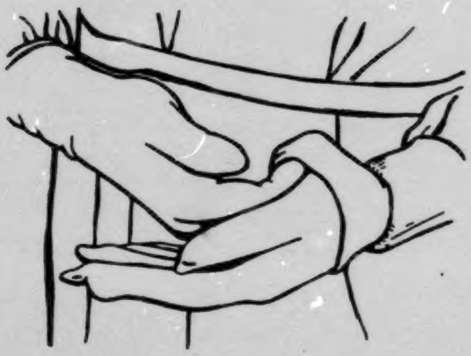
Step 12. Grasping turned-down cuff, pull the glove over the hand. Leave the cuff folded down.



Step 13. Pinch up the flap of the envelope over the left glove with the left hand. Insert the gloved fingers under the glove cuff and remove the glove. Do not allow the glove or gloved hand to touch the envelope. Discard gauze insert if present.



Step 14. Put on the left glove, keeping the gloved fingers of the right hand under the glove cuff. Pull cuff up over wrist, using care not to allow it to snap and roll. Place gloved fingers of left hand under cuff of right glove and pull cuff up over wrist.



Step 15. Adjust fingers of gloves to insure fit over fingertips.

b. Alternate Method. An alternate method of gloving is the closed cuff method. This method is preferred as the safer method when the specialist must glove himself. The specialist must, however, be wearing a sterile gown. This method eliminates several potential hazards in the glove procedure.

(1) The danger of contamination from glove cuffs rolling on skin surfaces is eliminated.

(2) The hands are not powdered and powder is not scattered on the floor or dispersed into the air.

(3) The gown cuff is anchored more securely by the glove. (The steps in TM 8–220 that require a sterile gown should be followed when this alternate method is used.)

6–34. Minor Operative Techniques—Open Wound Care

As a general rule, direct responsibility for open wound care other than the proper application of a first-aid dressing is NOT delegated to the medical specialist. Under supervision and direction of the medical officer, however, the medical specialist may be required to assist the medical officer directly with certain phases of wound care, such as preparation of an open wound for debridement or wound closure. When assisting in this fashion, the medical specialist functions as the sterile (scrubbed) assistant. The techniques discussed apply to treatment of a freshly incurred (within 6 to 8 hours of treatment), superficial, lacerated wound that does not involve nerve, large blood vessel, tendon, or deep muscle damage.

PREPARATION OF AN OPEN WOUND FOR OPERATIVE TREATMENT

Following initial evaluation of the patient's condition and the nature of the wound, the surgeon may direct the medical specialist to do a "surgical wound prep." This type of preparation is done using sterile technique.

Equipment

Presterilized prep set*
Sterile water, 1000 ml. flask
Sterile saline, 1000 ml. flask
Surgical soap
Plastic or rubber sheeting
Waste bucket
Sterile glove pack
Sterile brush pack
Sterile towel pack

Procedure

1. With assistance of circulator, place patient in required position, removing clothing to provide free access to the circumference of the affected area.
2. Place plastic or rubber sheeting under involved area to protect table linen and other parts of the patient from moisture. Form trough with free end of sheeting for drainage into waste bucket.
3. Cut away external portion of temporary dressing, using bandage scissors; leave wound area protected by internal dressing.
4. Focus light on area to be treated.
5. Place prep set on instrument stand adjacent to involved area. Open outer wrapper.
6. Do surgical hand scrub and gloving procedure.
7. Open inner wrapper of prep set.
8. Request circulator to pour sterile water into one basin and surgical soap into cup. (Save second sterile basin for sterile saline, for use later.)
9. With hemostat forceps, remove temporary dressing. Discard forceps and dressing.
10. With gloved hand, place folded gauze pads to cover wound completely and hold pads firmly in place.
11. With gauze fluffs, water, and soap, cleanse skin area for 3 or 4 inches adjacent to wound, using friction and working outward from wound margin. Do not retrace. Discard gauze after initial use, using fresh gauze as required.
12. Clip or shave, as appropriate, any visible hair at edges of wound and in area being cleansed.
13. Repeat skin cleansing, followed by clear water rinse, using gauze fluffs.
14. Following skin cleansing and removal of hair, irrigate wound (if so directed by the surgeon), following these steps:
    a. Discard protective gauze pad which has been on wound surface.
    b. Use asepto syringe and sterile saline, flushing entire open wound area with copious amounts of solution—500 ml. or more of solution may be used. With assistance of circulator, tilt patient, if possible, to direct flow of solution from wound toward rubber or plastic sheeting trough.

CAUTION

When the wound is irrigated, bleeding may occur as clots are dislodged and washed away. Never start irrigation procedure except under direct supervision of the surgeon, so that he may intervene immediately to identify and control the bleeding point by clamping with a hemostat or immediate ligation (tying off with suture). It may be necessary for you to apply direct firm pressure with sterile gauze to control bleeding as an interim measure until the surgeon takes over.

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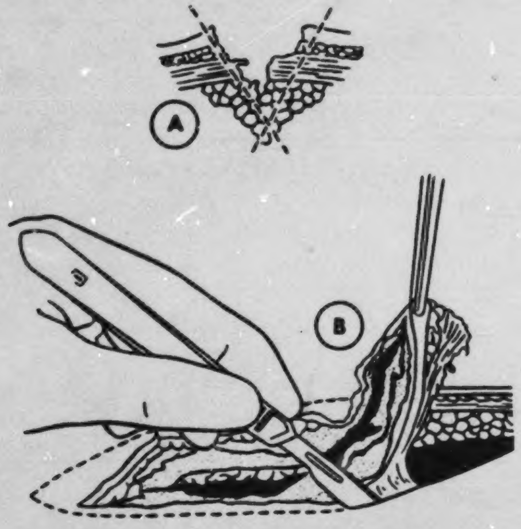
* Contents of prep set may vary. Usual items required are asepto syringe, 1; sponge basins, 2; solution cup, 1; thumb forceps; hemostat forceps; gauze fluffs, 12; gauze pads, 4- by 8-inch, 6; razor and blade; scissors.

   c. Remove visible foreign bodies (such as glass particles, gravel, bits of clothing, or detached bits of skin) that are not embedded in the tissue, using thumb forceps. Place removed particles on a gauze sponge for the surgeon's inspection. Do NOT probe into wound.

15. Following irrigation, place dry, sterile gauze pads lightly on wound surface. Dry adjacent skin area with sterile gauze.
16. Support affected body part while the circulator removes the wet rubber protector and places dry linen, as required, under the patient. Be very deliberate and gentle in all handling of the patient.
17. Place the patient in the desired position for the surgeon to continue operative treatment.
18. While the circulator places the sterile minor surgery tray in position for the surgeon, remove the prep tray from the site.
19. Remove gloves. If further assistance in a sterile capacity is required, complete a 3-minute hand scrub and put on fresh, sterile gloves.

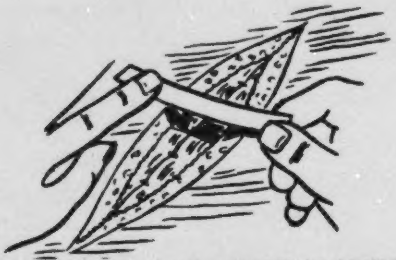
ASSISTING WITH SURGICAL DEBRIDEMENT

1. Surgical debridement involves the excision (cutting away) of all contaminated and dead tissue. The wound is enlarged, leaving clean, live tissue with freshly trimmed edges that can be apposed (brought together) for closure. In figure 6–9Ⓐ, a cross section diagram of a lacerated wound shows the irregular, damaged tissue margins that are trimmed in debridement, as indicated by the dotted lines in figure 6–9Ⓑ. The surgeon distinguishes live tissue from dead tissue by its color, consistency, contractibility, and capillary bleeding. Live tissue appears moist, pink, and firm to touch; the muscle will contract when stimulated by touch, and there will be free bleeding from cut capillary vessels. Dead tissue is described as being dark and having a mushy consistency.

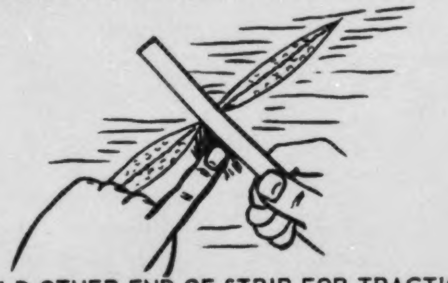


A CROSS-SECTION OF LACERATED WOUND.
B EXCISION OF DEAD AND CONTAMINATED TISSUE IN SURGICAL DEBRIDEMENT.

Figure 6–9. Debridement operative technique.

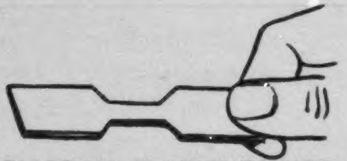


APPLY ONE-HALF OF ADHESIVE STRIP TO ONE SIDE OF SKIN AT MIDPORTION OF WOUND. PRESS FIRMLY INTO PLACE.
APPLY STRIP AT RIGHT ANGLES TO WOUND.

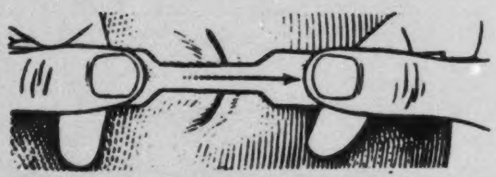


HOLD OTHER END OF STRIP FOR TRACTION. APPOSE SKIN EDGES EXACTLY, USING FINGERS OR FORCEPS, AND PRESS FREE HALF OF STRIP INTO PLACE.

Figure 6–10. Sutureless skin closure, sterile strip technique.

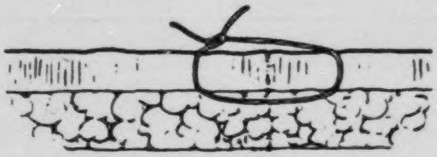


CUT 4 DIAGONAL SLASHES TOWARD CENTER OF STRIP AND FOLD UNDER EDGES TO MAKE A NONADHERENT BRIDGE. FLAME THE UNDERSIDE OF THE BRIDGE, HOLDING A MATCH OR LIGHTER JUST CLOSE ENOUGH TO SCORCH THE FABRIC. DO NOT TOUCH THE FLAMED PORTION AS THIS WILL LIE OVER THE WOUND EDGES. ALLOW HEATED PORTION TO COOL.

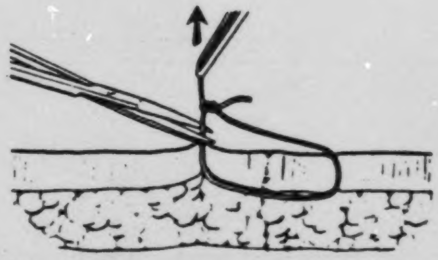


ATTACH ADHESIVE PORTION AT RIGHT ANGLE TO ONE SIDE OF LACERATION. PRESS FIRMLY TO ANCHOR IT TO THE SKIN. APPLY TRACTION TO OTHER END OF STRIP TO APPOSE SKIN EDGES. ANCHOR FREE END.

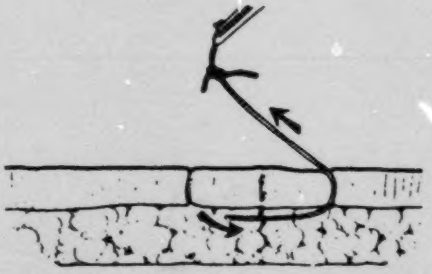
Figure 6–11. Sutureless skin closure: butterfly tape technique.



STEP 1. NOTE THAT THE SUTURE KNOT IS LOCATED TO ONE SIDE OF THE INCISION LINE. THE SUTURE IS CUT BELOW THIS KNOT ON THE SAME SIDE.



STEP 2. GRASP ONE END OF THE SUTURE WITH THE FORCEPS AND PULL UP. MAINTAIN GENTLE TRACTION UPWARD TO EXPOSE A SMALL PORTION OF THE SUTURE THAT HAS BEEN JUST BELOW THE SKIN SURFACE. CUT THE SUTURE BELOW THE PORTION ORIGINALLY EXPOSED AT THE SURFACE. PLACE THE ROUNDED TIP OF THE SCISSORS NEXT TO THE SKIN SURFACE. (SUTURE SCISSORS HAVE ONE ROUNDED AND ONE SHARP TIP.)



STEP 3. PULL THE CUT SUTURE UP AND OUT OF THE SKIN.

Figure 6–12. Removing skin sutures.

2. While performing the debridement, the surgeon identifies bleeding points and controls any excessive bleeding. If irrigation of the wound is required, the surgeon may instruct his scrubbed assistant to direct a stream of sterile saline into the wound to wash out loosened particles. Following irrigation, wet sterile drapes are removed, and fresh sterile drapes and towel clips are used.

WOUND CLOSURE TECHNIQUES

The medical specialist will usually not be directly involved in the handling of wound closure materials such as suture needles or suture thread. Sterile, commercial-packed suture in plastic or foil packets is usually available for use in the dispensary, and the medical officer handles the suture and manipulates the wound tissue without direct assistance. (TM 8–220 gives background information on suture material and techniques.) The medical specialist may be directed to apply specially prepared adhesive strips for sutureless wound closure. This technique is used for closure of a small, shallow incision when gaping is minimal and skin edges can be apposed with no difficulty. Two types of sutureless closures may be used—a commercially packaged sterile strip or an improvised butterfly adhesive closure.

1. *Sterile skin closure strip* (fig. 6–10). These

strips are made of porous, nonirritating material and the adhesive surface is applied directly to the wound surface. Usually three ¼-inch wide, 3-inch long strips are packaged in a peel-back plastic enclosure. The strips are handled with sterile gloves and the operator may use his gloved fingers to bring the skin edges together exactly. One or more strips are used for closure. A sterile dry dressing is applied over the strips.

2. *Butterfly adhesive closure* (fig. 6–11). A butterfly adhesive closure is made from an ordinary 1-inch-wide, 3-inch-long adhesive strip. It provides less exact skin closure than a commercially prepared sterile strip, but it is a useful improvised measure. A sterile dry dressing may be applied over the butterfly strip for protection, but the surface of the strip is not sterile.

SKIN SUTURE REMOVAL TECHNIQUE

When directed by the medical officer, the medical specialist may remove skin sutures from selected patients as a postoperative care measure. In removing sutures, an essential point is to avoid pulling the end of the suture that has been exposed above the skin back through the skin, as this could implant contaminants along the suture line. A recommended aseptic technique is given and illustrated in figure 6–12. Use a sterile suture removal set consisting of scissors and a thumb forceps or hemostat forceps. As a general rule, do not apply any antiseptic solution before removal of sutures unless directed by the medical officer to do so.

Section V. INTRODUCTION TO UNIT LEVEL MEDICAL SERVICE

6–35. Field Medical Service at Unit Level

a. The Aidman Element. The field medical service begins at the unit level, with attachment of the aidman element to each subordinate company, troop, or battery of a combat battalion. The unit-level medical support provided by the aidman element is planned and directed by the battalion surgeon, the Medical Corps officer assigned as a commander of the medical element of the battalion. Unit-level medical service is covered in detail in FM 8–15. A brief discussion of the functions of the aidman at unit level, in a company aid post, is included in this manual in order to emphasize that in combat and noncombat operations, initial medical care of combat troops starts with the care provided by the aidman, MOS 91B20 (medical specialist), and with the senior medical aidman (MOS 91B40) as NCOIC of the aidman element.

NOTE

Initial unit-level professional medical treatment starts with the arrival of the casualty at the battalion aid station in the normal flow of evacuation.

b. Unit-Level Medical Service Responsibilities. Major responsibilities include the following.

(1) *In combat.* Acquire sick and wounded casualties from forward locations, administer emergency medical treatment, and evacuate patients requiring professional medical treatment.

(2) *During noncombat periods.* Unit-level medical personnel operate a unit dispensary; conduct medical MOS training; and, when required, provide instruction to nonmedical personnel in first aid, field sanitation, and personal hygiene procedures.

(3) *Throughout combat and noncombat periods.* Unit-level medical personnel maintain preventive medicine activities.

c. Functions of Aidmen In Unit-Level Medical Service Combat Support.

(1) *Aidmen.* Aidmen perform the following:

(*a*) Provide emergency medical care.

(*b*) Return to duty those patients requiring no further treatment.

(*c*) Direct ambulatory patients requiring further treatment to the company aid post or battalion aid station.

(*d*) Arrange medical evacuation for litter patients.

(*e*) Initiate field medical cards for sick, injured, and wounded patients.

(*f*) When time permits, initiate and complete field medical cards for deceased personnel.

(2) *Senior medical aidmen.* The NCOIC of the aidmen element will—

(*a*) Screen, evaluate, and provide medical treatment for conditions within his capability and return to duty those patients requiring no further attention. Patients requiring additional treatment will be evacuated to the aid station.

(*b*) Operate a company aid post near the company command post. Patients evacuated to the company aid post remain at that location pending appropriate disposition.

(*c*) Coordinate and direct the activities of supporting aid-evacuation teams operating in the company area.

(*d*) Keep the company commander informed of the medical status in the company area.

(*e*) Report matters detrimental to the health of the command to the platoon or company commander and the battalion surgeon.

(*f*) Supervise hygiene; sanitation; and the selection, treatment, and handling of water for consumption. The senior medical aidman may serve as a member of the unit field sanitation team.

6–36. Preventive Medicine

Adequate preventive medicine practices are an important part of the unit-level medical mission at aid posts and aid stations. The medical specialist will find much of the information he needs in AR 40–5 and FM 21–10.

a. Among the preventive medicine inspections he may be required to conduct on the site are—

(1) Routine inspection of food.

(2) Messhall inspection.

(3) Barracks inspection.

(4) Inspection of water and sewage disposal systems.

b. In addition to inspection duties, he may also be required to—

(1) Keep records of personnel who must have periodic physical examinations such as food handlers and persons who handle volatile fuel material.

(2) Establish schedules and immunize personnel (AR 40–562), coordinating the schedule with the personnel officer.

(3) Instruct personnel on—

(*a*) Venereal diseases.

(*b*) Respiratory disease control.

(*c*) Intestinal diseases.

(*d*) Personal hygiene.

c. He may be required to prepare information for the monthly preventive medicine reports, which will be submitted through the unit commander either to the support unit or to the supporting division surgeon's office.

6–37. U.S. Field Medical Card (DD Form 1380)

a. *General*. The U.S. Field Medical Card (FMC) is the individual medical record used by aid stations and clearing stations and by nonfixed dispensaries that operate while overseas, while on maneuvers, or while attached to commands moving between stations (AR 40–400). The FMC is designed for use in forward combat areas where keeping detailed clinical records is impractical. Its main purpose is to furnish medical officers who see the casualty during evacuation with essential information about the casualty's injury or disease and the treatment given him.

b. *Description*. The field medical card is made so that it can be attached to a casualty. The cards are issued as a pad, each containing complete sets. A set consists of an original card, a sheet of carbon paper, a carbon protective sheet, and a duplicate. The front side of the card has spaces for the casualty's name, serial number, diagnosis, treatment, and other essential information. The reserve side of the card has space for additional entries when needed. In preparing the FMC, first remove and discard the carbon protective sheet. (Retain the carbon if the reverse side is being completed.) Unless otherwise directed, fasten the original of the FMC initiated on admission (by an aidman or personnel of the medical treatment facility) to the patient's clothing and leave it there while the patient is being transferred between Army medical treatment facilities which use the FMC as the individual medical record. Retain the duplicate in the pad for use as the theater surgeon prescribes.

c. *Preparation*. The U.S. Field Medical Card will be prepared by aid stations, collecting stations, clearing stations, and nonfixed dispensaries that operate while overseas, while on maneuvers, or while attached to commands moving between stations.

(1) *When prepared*. For each direct admission and for each carded for record only (CRO).

(2) *By whom prepared*. The U.S. Field Medical Card will be completed by, or under the supervision of, a medical officer of the medical treatment facility involved. Company aidmen first attending casualties in the field may initiate the U.S. Field Medical Card by recording such entries as are sufficient to identify the individual and by briefly describing medical aid given such as plasma, morphine, or splinting. The medical aidman places his initials in the extreme right portion of the space provided for signature. The U.S.

Field Medical Card will be reviewed, completed, and signed by a medical officer or his designee.

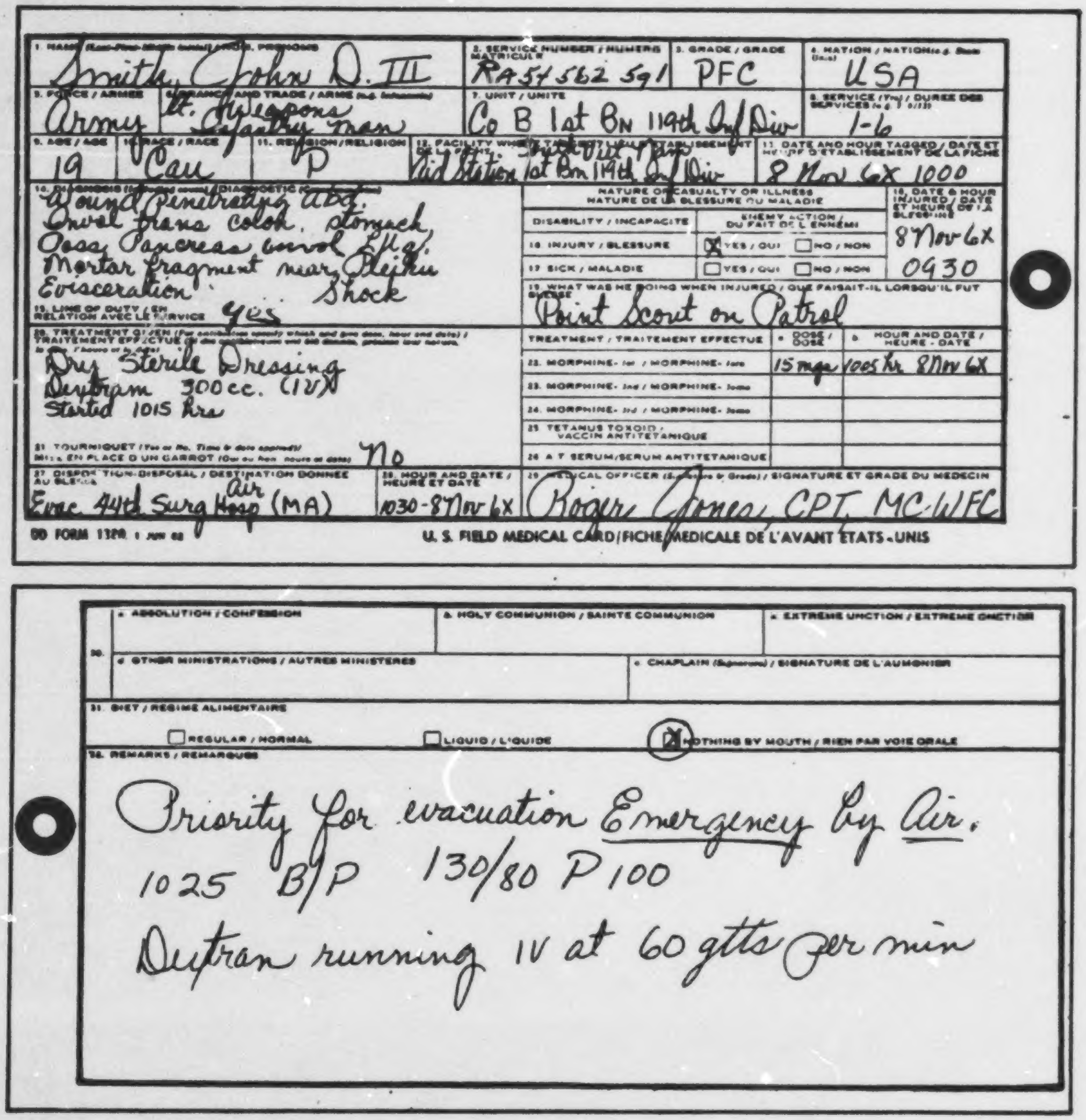
d. Source of Data.

(1) *Identification of a patient.* Information may be secured from the patient or from such things as identification tags and personnel records.

(2) *Medical information.* Medical information such as diagnosis, operations, and treatment will be entered directly on the U.S. Field Medical Card by medical officers and others attending the patient, ordinarily at the time of attendance.

e. Entries. Aid stations under conditions of extreme stress may only partially complete the U.S. Field Medical Card for patients being transferred elsewhere. Otherwise, all entries will be completed as far as possible. Figure 6–13 is a sample completed Field Medical Card.

f. Supplemental Field Medical Card. Whenever additional space is required, another FMC, labeled in the upper right-hand corner "FMC No. 2," and containing appropriate identifying information, will be attached to the original. The second card used is the Supplemental Record. More supple-



1. NAME / NOM, PRENOMS: Smith, John D. III
2. SERVICE NUMBER / NUMERO MATRICULE: RA 54 562 591
3. GRADE / GRADE: PFC
4. NATION / NATION: USA
5. FORCE / ARMEE: Army
6. BRANCH AND TRADE / ARME: Lt. Weapons Infantry man
7. UNIT / UNITE: Co B 1st Bn 119th Inf Div
8. SERVICE (Yrs) / DUREE DES SERVICES: 1-6
9. AGE / AGE: 19
10. RACE / RACE: Cau
11. RELIGION / RELIGION: P
12. FACILITY WHERE TAGGED / LIEU D'ETABLISSEMENT DE LA FICHE: Aid Station 1st Bn 119th Inf Div
13. DATE AND HOUR TAGGED / DATE ET HEURE D'ETABLISSEMENT DE LA FICHE: 8 Nov 6X 1000
14. DIAGNOSIS / DIAGNOSTIC: Wound Penetrating Abd. Invol trans colon, stomach, Poss. Pancreas invol Eff. Mortar fragment near Pleiku Evisceration Shock
15. LINE OF DUTY / EN RELATION AVEC LE SERVICE: yes

NATURE OF CASUALTY OR ILLNESS / NATURE DE LA BLESSURE OU MALADIE

DISABILITY / INCAPACITE	ENEMY ACTION / DU FAIT DE L'ENNEMI	
16. INJURY / BLESSURE	☒ YES / OUI	☐ NO / NON
17. SICK / MALADIE	☐ YES / OUI	☐ NO / NON

18. DATE & HOUR INJURED / DATE ET HEURE DE LA BLESSURE: 8 Nov 6X 0930
19. WHAT WAS HE DOING WHEN INJURED / QUE FAISAIT-IL LORSQU'IL FUT BLESSE: Point Scout on Patrol
20. TREATMENT GIVEN / TRAITEMENT EFFECTUE: Dry Sterile Dressing Dextram 300cc. (IV) Started 1015 hrs

TREATMENT / TRAITEMENT EFFECTUE	a. DOSE / DOSE	b. HOUR AND DATE / HEURE - DATE
22. MORPHINE- 1st / MORPHINE- 1ere	15 mgs	1005 hr 8 Nov 6X
23. MORPHINE- 2nd / MORPHINE- 2eme		
24. MORPHINE- 3rd / MORPHINE- 3eme		
25. TETANUS TOXOID / VACCIN ANTITETANIQUE		
26. A T SERUM/SERUM ANTITETANIQUE		

21. TOURNIQUET / MISE EN PLACE D'UN GARROT: No
27. DISPOSITION-DISPOSAL / DESTINATION DONNEE AU BLESSE: Evac. 44th Surg Hosp (MA) Air
28. HOUR AND DATE / HEURE ET DATE: 1030-8 Nov 6X
29. MEDICAL OFFICER / SIGNATURE ET GRADE DU MEDECIN: Roger Jones, CPT, MC-WFC

DD FORM 1380, 1 JUN 62 U.S. FIELD MEDICAL CARD/FICHE MEDICALE DE L'AVANT ETATS-UNIS

30. a. ABSOLUTION / CONFESSION
b. HOLY COMMUNION / SAINTE COMMUNION
c. EXTREME UNCTION / EXTREME ONCTION
d. OTHER MINISTRATIONS / AUTRES MINISTERES
e. CHAPLAIN / SIGNATURE DE L'AUMONIER

31. DIET / REGIME ALIMENTAIRE
☐ REGULAR / NORMAL ☐ LIQUID / LIQUIDE ☒ NOTHING BY MOUTH / RIEN PAR VOIE ORALE

32. REMARKS / REMARQUES
Priority for evacuation Emergency by Air.
1025 B/P 130/80 P 100
Dextran running IV at 60 gtts per min

Figure 6–13. Sample of completed U.S. Field Medical Card.

mental cards may be added as needed, but they will be numbered in sequence.

g. Disposition of U.S. Field Medical Cards. Disposition of U.S. Field Medical Cards is shown in table 6–1.

Table 6–1. Disposition of U. S. Field Medical Card

Disposition	Original	Duplicate
COMBAT SITUATION Admission & Disposition.	OTSG	Health Record
CRO	OTSG	Health Record
Outpatient Treatment	Health Record	Destroy after 3 months
TRANSFER	To receiving facility	Health Record
NONCOMBAT SITUATION Admission or CRO with/disposition duty or health.	OTSG	Health Record
Transfer	To receiving facility	Destroy after 3 months

(1) *Completed cases.* If the patient is returned to duty or carded for record only, the original copy of the FMC is kept by the medical treatment facility making disposition of the case. Later the facility sends this copy to The Surgeon General. The card should never go with the patient to his organization. When a patient is killed in action or dies in, or on the way to, a medical treatment facility, the original is left attached to the body until it reaches the place of burial. Then it is removed for transmittal to The Surgeon General.

(2) *Transfered cases.* When a patient is transferred from one medical treatment facility to another farther to the rear, the card goes with the patient. It remains attached to him until he reaches a hospital, dies and is buried, or until he is returned to duty.

(3) *Carbon copies.* In oversea commands, carbon copies (duplicates) of FMC are used as the theater surgeon prescribes. In the United States, the senior medical officer prescribes the use of carbon copies of the cards.

NOTE: MIS NUMBERED, P. NO. 182 IS MISSING, HOWEVER
ALL MATERIAL IS INCLUDED

Section VIII. FRACTURES, DISLOCATIONS, AND SPRAINS

8–21. Injuries to the Skeleton

Bones, being essentially nonyielding structures, are damaged when excessive force is applied to them. The nature of the damage depends upon the direction of the applied force on the bones and the way in which these bones are attached to other bones. The principal acute skeletal injuries are fractures, dislocations, and sprains.

8–22. Definition of Fracture

A fracture is a break in the continuity of a bone or a separation of a bone into two or more parts. A great amount of soft tissue damage often accompanies this type of injury.

8–23. Kinds of Fractures

Fractures are classified as open and closed. An open fracture is one in which there is a break in the skin that is continuous with the fracture. The bone is either protruding from the wound or exposed through a wound channel such as one produced by a bullet, shell fragment, or other missile. A closed fracture is not complicated by a break in the skin; however, there may be soft tissue damage beneath the intact skin.

8–24. Symptoms of Fracture

A tentative or conclusive diagnosis of fracture may be based on any one of the symptoms below. Additional assistance in diagnosis may be obtained from the patient. A history of falling or of having felt or heard a bone snap may help in the discovery of the more precise evidence listed below.

a. Deformity of the Part. Protrusion of a bone segment through the skin or unnatural depression or flexion indicate fracture.

b. Tenderness Over Site of Injury. Tenderness or pain upon slight pressure on the injured part may indicate a fracture.

c. Swelling and Discoloration. Swelling and discoloration at the site of injury increase with time and may indicate fracture. The swelling is due to the accumulation of tissue fluid and blood. When blood collects near the surface of the skin, a bluish discoloration may be seen.

d. Abnormalities With Movement. Deep, sharp pain upon attempt to move the bone is presumptive evidence of fracture. Grating of bone ends against each other indicate fracture. Movement, however, should NEVER be attempted for purpose of making a diagnosis, as it causes further damage to the surrounding tissues and promotes shock.

8–25. Signs and Symptoms in Regional Fractures

In addition to the general symptoms which may be present, a fracture in a specific region of the skeleton may be accompanied by signs or symptoms peculiar to that region.

a. Fracture of the Skull. There may be bleeding or leakage of spinal fluid from nose, mouth, or ears; difference in size of eye pupils; blackening of tissues under the eyes; changes in pulse and respiration that are not necessarily compatible with the blood picture (table 8–3), and paralysis or twitching of muscles. Head injury should be suspected in persons unconscious in a nonpoisonous atmosphere.

b. Fracture of the Neck or Spinal Column. If the spinal cord is injured, there may be loss of sensation or paralysis below the site of the fracture. There may also be loss of control of bladder and bowel. If the space in which the spinal fluid flows between the spinal cord and the surrounding vertebral column is either compressed or enlarged, severe headache occurs.

c. Fracture of the Jaws. Symptoms may include abnormal closure of teeth, inability to swallow or talk, and bleeding and drooling from the mouth. In cases of fracture of both jaws, especially, the soft tissues may drop back into the throat and strangle the patient.

d. Fracture of the Clavicle. Fractured ends sometimes can be felt under the skin. The involved shoulder may be lower than the other. The patient is unable to raise the involved arm above the shoulder; he usually supports the elbow of the involved side with the opposite hand.

e. Fracture of the Rib. Pain, if present, is felt most sharply on inspiration or coughing. The break sometimes can be felt with the fingers. If the lung is punctured, the patient may cough up bright red, frothy blood.

f. Fracture of the Pelvis. The patient, unable to stand or walk, complains of pain in the pelvic region and, if the bladder or kidney is injured, passes blood in the urine.

8–2[illegible]. Emergency Treatment of Patients With Fractures

a. The first step is to make a brief but thorough examination of the patient to determine the extent of his injuries. Treatment of any life-endangering condition, such as respiration failure, heart failure, or hemorrhage, takes precedence over that for fracture. The treatment applied directly to the fracture is a part of the prevention or lessening of shock, since pain is lessened and likelihood of further trauma is reduced. In addition, morphine may be required to relieve extreme pain from fracture.

b. In the treatment for fractures, the rule, "splint them where they lie," applies. Open fractures are dressed before splints are applied. Care must be taken to avoid moving the fractured part, as the razor-sharp ends of a fractured bone can cut through blood vessels, nerves, and skin. Such additional damage would, of course, increase the possibility of hemorrhage, shock, loss of limb, and loss of life. If movement of the patient is unavoidable or is essential in treatment, the fractured part must be supported if further damage is to be avoided. Slight adjustment of the fractured part may be necessary to restore circulation, the lack ofwhich is evidenced by absence of pule distal to the fracture.

c. To prevent futher damage, a fractured bone must be immobilized. Immobilizing a fractured limb requires splinting the joint above and the joint below the fracture, as movement of these joints would move the bone segments. If possible, the injured part and hands and feet of involved limbs are splinted in the position of function so that the part will be useful to some degree should stiffening or other loss of motion occur. Traction is applied only when the necessary equipment is available.

d. It is very important that all splints be well padded to protect the skin from injury, loss of circulation, inflammation, and infection. If cotton batting or suitable soft fabric is not available, substitutes (leaves, grass, moss) may be used for padding. Bandages used to secure a splint must not be applied so tightly that they impair circulation or have the effect of a tourniquet. A bluish discoloration of the nailbeds or skin of the af-

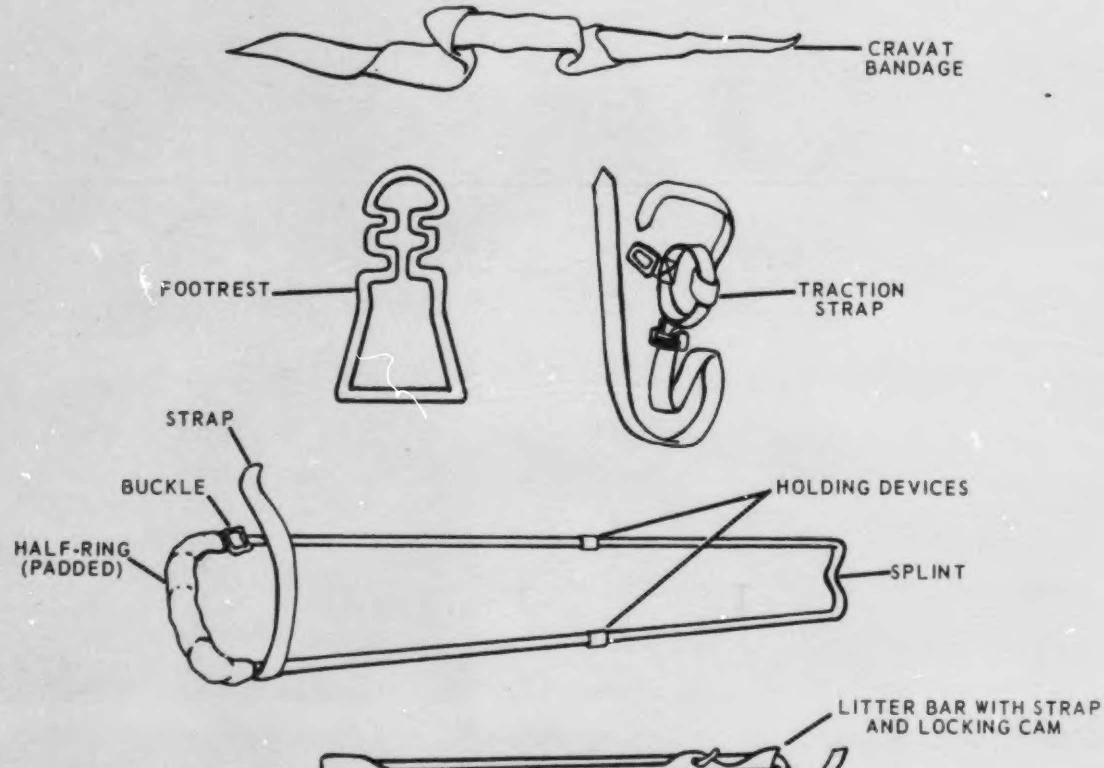


Figure 8–16. Half-ring Thomas splint, telescope type.

fected limb indicates that one or more bandages have been applied too tightly.

WARNING

> Bandages should not be tied across a wound.

e. Splints commonly used to immobilize fractures of the extremities are the wire ladder and Thomas leg splint. If this equipment is not available, splints may be improvised, using such items as tree limbs, boards, rolled newspapers, belts, and rifles.

WARNING

> Before any weapon is used as a splint, it must first be unloaded.

To immobilize a fractured bone in the thigh or hip, the improvised splint must extend from the groin and the armpit to several inches below the foot. Moreover, the padding should extend over the ends of the splint at the groin and the armpit.

f. Methods of immobilizing, supporting, and transporting persons with fractures are covered in FM 21-11 and FM 8-35.

8-27. Thomas Leg Splint

The half-ring Thomas leg splint with supporting equipment (fig. 8-16) is used to apply traction and immobilize fractures of the lower extremities, making it possible to transport the patient a considerable distance under primitive conditions without further damage. Application of the Thomas leg splint requires the coordinated efforts of three people working as a splinting team. Open fractures are dressed before the splint is applied. Traction is applied to overcome the effect of contraction of the large muscles of the lower extremity. This contraction forces broken ends of bone out of alinement or against each other, which generates pain and the possibility of further damage. Traction, properly applied, overcomes this pressure (fig. 8-17). Traction is not applied when part of the limb is amputated.

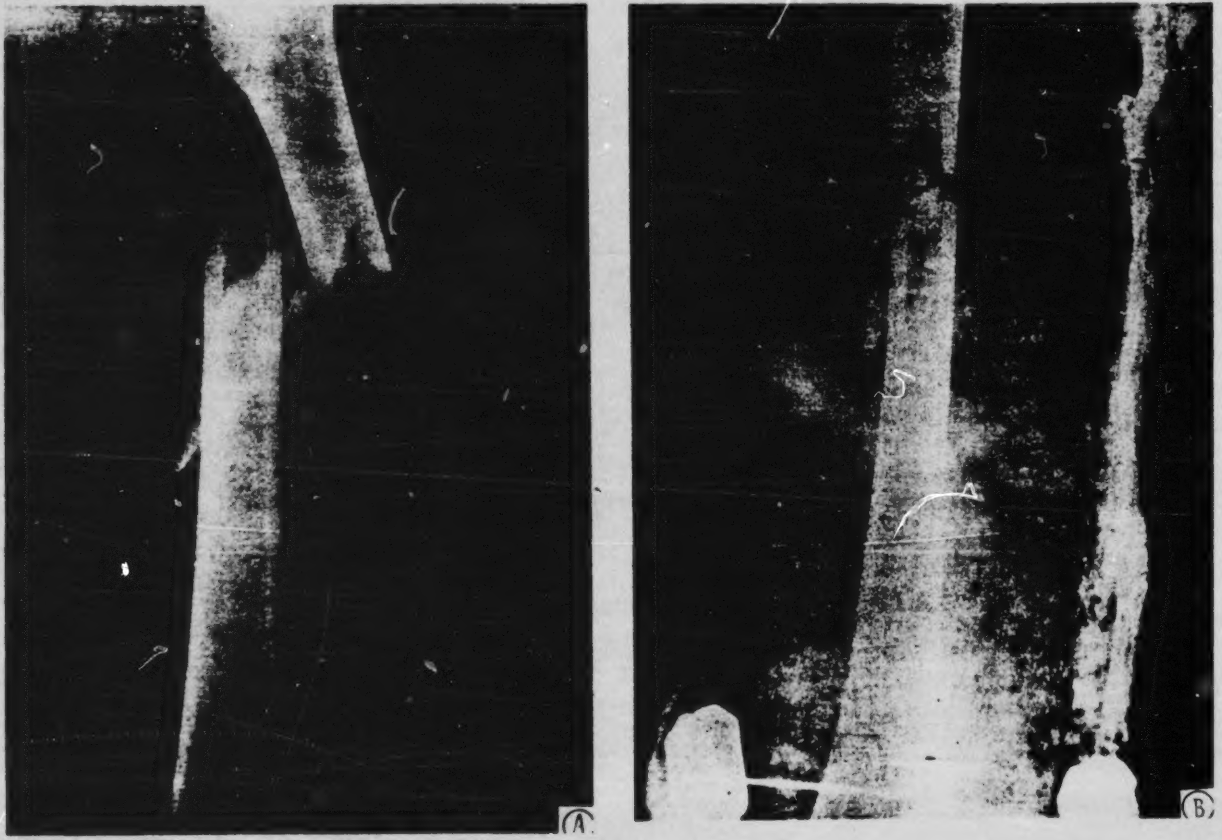


Figure 8-17. X-ray photograph of fractured femur before application of traction Ⓐ and after Ⓑ.

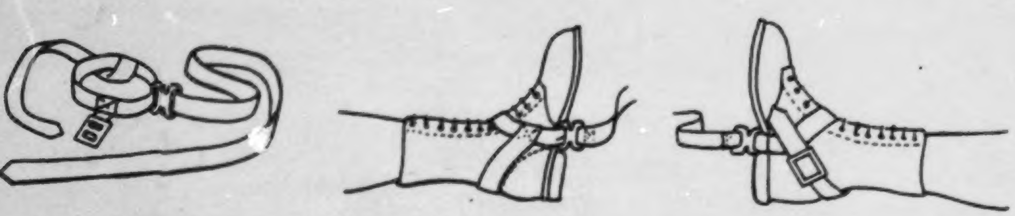


Figure 8-18. Application of traction strap.

a. Adjustments of the Splint for Length.

(1) The telescoping splint may be adjusted to three lengths, one of which will best serve the patient at hand. Too short a splint will not leave sufficient room to apply traction to the foot. Too long a splint will not permit use of the limited length of the traction strap. To determine the best length in which to lock the splint, place the splint alongside the uninjured leg with the ring portion parallel to the ischium (bone in the buttock) and extend the splint about 6 to 8 inches beyond the foot. Lock the holding devices.

(2) Place the adjusted splint, with the buckle on the outside, alongside the broken extremity.

b. Team Application of Splint and Supporting Equipment.

(1) No. 1 member: apply the traction strap over the shoe on the patient's foot (fig. 8-18). If the patient is shoeless or has only low quarter shoes, place plenty of soft materials free of seams and wrinkles over the areas on which the traction strap will pass. After fastening the strap, position yourself so as to face the sole of the patient's foot, run one hand through the large opening in the footrest and under the outside rod of the splint, and grasp the back of the patient's heel. With the other hand, grasp the dorsum of the patient's foot. Initiate and maintain traction throughout the remainder of the application procedure (fig. 8-19). Maintenance of traction is very important. Release may cause serious and unnecessary damage.

NOTE

No. 1 member may have his right hand uppermost or his left hand uppermost when grasping the foot. Whichever way he starts, he should continue. He does not release traction or change position while the splint is being applied.

(2) No. 2 member: raise and support the extremity; maintain this support throughout the application procedure (fig. 8-19).

(3) No. 3 member: apply the splint and attach the supporting equipment in accordance with the following procedure:

(*a*) With the buckle of the splint to the outside and the half-ring bent down at a right angle, ease the splint under the leg, setting the padded half-ring against the ischium (fig. 8-19).

(*b*) Place a pad over the thigh at the location of the splint strap and fasten the strap.

(*c*) Bring the long free end of the traction strap over and under the notched end of the

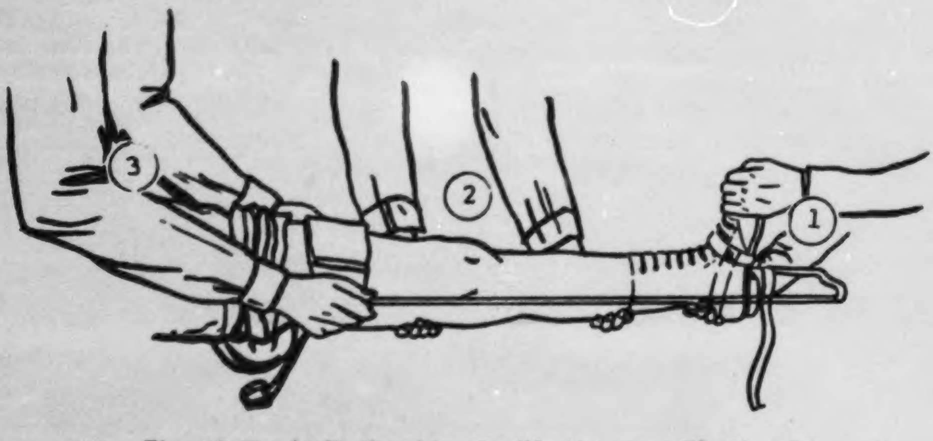


Figure 8-19. Application of traction (No. 1), support (No. 2), and splint (No. 3) to patient's right lower extremity.

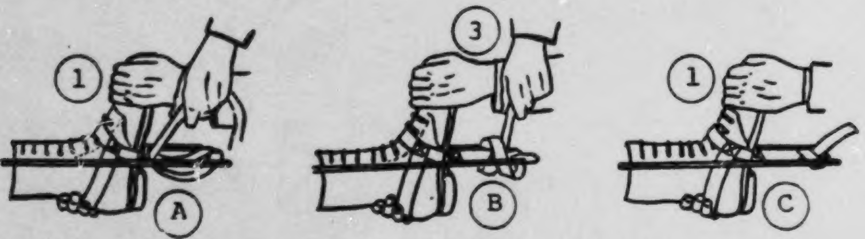


Figure 8-20. Fastening traction strap to splint.

splint; then pass it up through the link at the swivel (fig. 8-20Ⓐ). Secure greeter traction by pulling the strap toward the end of the splint. Fasten the strap securely (fig. 8-20Ⓑ). No. 1 member must continue to support foot until footrest is applied (fig. 8-20Ⓒ).

(*d*) Apply two cravat bandages to help support the leg. If triangular bandages for folding into cravats are not available, use other strong, cloth material that is at least 3 inches wide. Place each cravat across the rods of the splint (fig. 8-21Ⓐ), with the long end of the bandage to the outside. Make sure that neither bandage, when later tied, will be directly over the fracture. Bring ends under splint and loop in opposite direction (fig. 8-21Ⓑ). Bring the longer tail over the patient's leg and tie the two ends over the outside rod (fig. 8-21Ⓒ) with a square knot (fig. 8-12Ⓐ). (No. 2 member must continue to support leg.)

(*e*) Slide footrest over end of splint and into place against shoe or padding on sole of foot (fig. 8-22). (No. 1 continues to hold patient's foot steady, adjusting it slightly as necessary so that heel and sole of shoe or padded foot are in light contact with the footrest.)

(*f*) Apply three or four cravat bandages as before to further support the extremity (fig. 8-23). Make sure that no bandage is placed directly over the fracture site. (No. 2 shifts, then releases support as bandages are tied.)

(*g*) Finally, apply two cravat bandages to further support the foot and ankle and secure the foot to the footrest (fig. 8-24).

- Place one cravat under the back of the shoe, bringing both ends up and crossing them on top of the shoe; then carry the ends toward the sole of shoe and tie on the outside of the footrest.
- Apply the second cravat around the toe of the shoe and footrest and tie. (No. 1 man releases as bandages are applied.)

c. Movement of Patient Onto Litter. After the splint and supporting equipment have been applied, and before the patient is transported, he should be moved onto a litter which, preferably, has been dressed with blankets as shown in figure 8-25.

(1) No. 2 and 3 kneel alongside the patient on the side of the splinted limb. No. 1 member kneels on the opposite side. Each member kneels on the knee nearest to the patient's feet. No. 1 places both hands under the patient's back and thighs; No. 2 supports the legs and No. 3 the shoulders and back. All three then lift the patient onto the thighs of No. 2 and 3.

(2) No. 2 and 3 support patient on their thighs while No. 1 places litter in position alongside their knees, which are touching the ground. No. 1 then helps No. 2 and 3 lower the patient gently onto the litter, supporting patient with hands in same positions as when lifting. As the patient is lowered, the positioning should be such that the footrest on the splint will rest on the

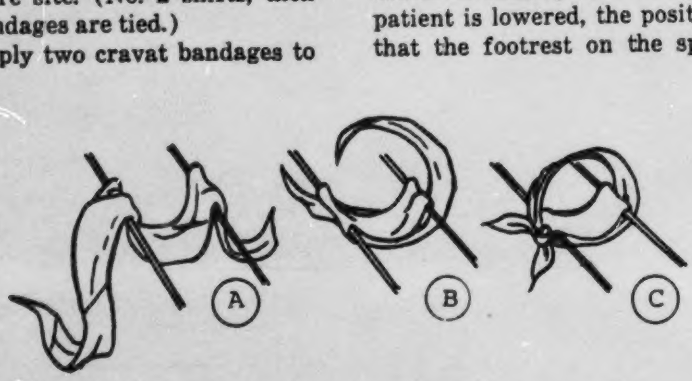


Figure 8-21. Placement of cravats on rods of Thomas splint.

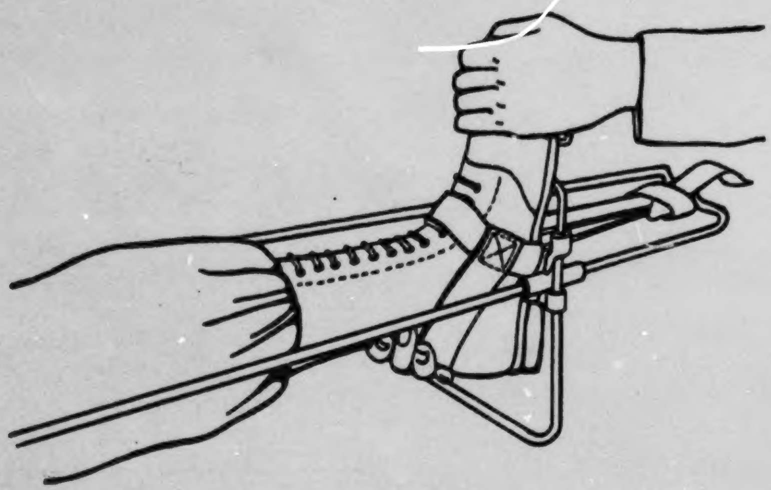


Figure 8-22. Footrest in place.

blankets on the dressed litter 2 inches from the border of and on the litter canvas.

d. Securing Footrest to Litter. The footrest is secured to the litter with a grooved litter bar.

(1) No. 1 member: lift and hold footrest steady a few inches above the litter canvas.

(2) No. 3 member: slide the litter bar under the footrest, guiding the bottom of the footrest into the groove in the litter bar. Start the bar from the direction of the fractured limb and slide it toward the other leg.

(3) Lock the litter bar to the footrest by turning the handle of the locking cam.

(4) No. 1 member: lower footrest so that litter bar is on or at the level of the litter canvas. Release now or after step (5) as indicated.

(5) No. 3 member: buckle litter bar strap tightly around the litter poles.

e. Prevent or Lessen Shock. No. 2 member: cover patient with blankets or other materials as his condition and the situation warrant and place patient in proper position to prevent or lessen shock.

f. Substitutes for Traction Strap and Litter Bar. If a traction strap and a litter bar are not available, roller bandage, cravat bandages, or similar strong material may be used as substitutes. (FM 21-11 gives additional details.)

8-28. Dislocations

A dislocation is the displacement of the normal relationship of the articular (contacting) surfaces of the bones that make up a movable joint. Dislocation places considerable strain on the ligaments which normally hold the bones of the joint in position. There may be injury to these ligaments, the capsule they form around some types of joints, and other soft tissues, as well as hemorrhage into or around the joint.

a. Symptoms. Pain, swelling, and deformity are centered about the joint. Usually there is also loss of motion.

b. Emergency Treatment. A dislocation is immobilized in the same way as a fracture close to the joint. Cold compresses may be applied to the joint to relieve pain and reduce swelling, but the patient's temperature must not be lowered so as

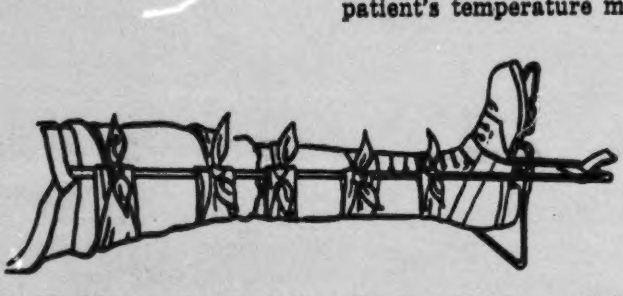


Figure 8-23. Support of extremity by splint, cravat bandages, and footrest.

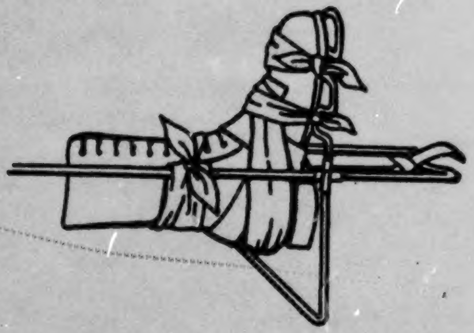


Figure 8-24. Foot supported and secured.

to invite shock. Specialists having good knowledge of joint anatomy and physiology may reduce the dislocation when a physician is not immediately available; otherwise, morphine may be the only means for relieving pain so severe that it could precipitate shock.

8-29. Sprains

A sprain is a joint injury in which the ligaments, capsule, and surrounding tissues are partially torn or severely stretched without dislocation being present. There may have been a partial dislocation that spontaneously reduced itself.

a. Symptoms. The symptoms of a sprain are pain, swelling, reduced motion, and hemorrhage into the surrounding tissues, causing discoloration of the skin.

b. Emergency Treatment. The sprained part should be elevated and treated with cold packs to reduce swelling and relieve pain. A sprained ankle may be supported with an ankle hitch. If there is any doubt as to the severity of the injury, it should be treated as a fracture.

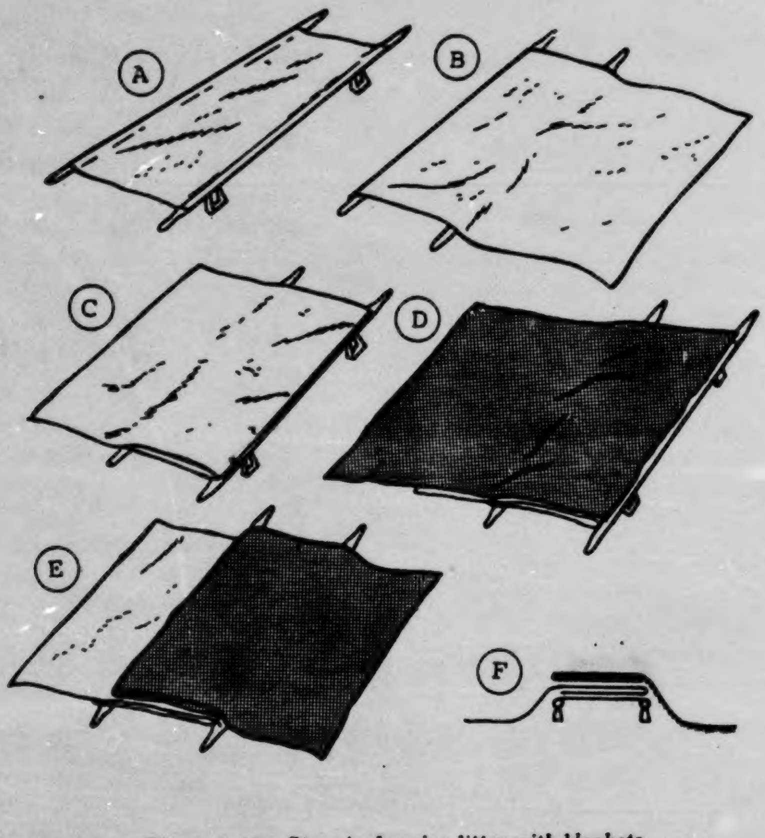


Figure 8-25. Steps in dressing litter with blankets.

Section IX. BURNS

8–30. Causes

Burns are the tissue damage caused by excessive exposure to heat or to other noxious agents including chemicals, electricity, and ionizing radiation. For the most part, burns caused by agents other than heat are treated as thermal (heat) burns.

8–31. Severity

The severity of burns is measured by the degree or depth to which the tissues are injured and by the extent or percent of body surface burned.

a. Degrees of Burns.

(1) *First degree.* A first degree burn is superficial; it involves only the outer layers of the epidermis. A typical example is the sunburn in which the skin is red and painful, but with no blisters or fluid loss. It is not an open wound and, for this reason, does not become infected.

(2) *Second degree.* The second degree (partial thickness) burn extends into but not completely through the dermis, destroying or damaging skin cells, glands, blood vessels, and other structures. This burn is characterized by redness, pain, blisters, and sometimes exuded matter. Body fluids are lost through the damaged skin. The second degree burn is an open wound susceptible to infection.

(3) *Third degree.* A third degree (full thickness) burn destroys all layers of the dermis and may extend through the subcutaneous tissue into the skeletal muscle and underlying bone. There may be amputation of parts. This burn is characterized by insensitivity to pain (since nerve branches in the area are destroyed) and a hard dry surface which is either charred or pearly white. The surface is usually depressed below that of the surrounding, painful, second degree burn. Enormous amounts of body fluids are lost into the damaged tissues and through the nonviable skin. The third degree burn is an open wound highly susceptible to infection.

b. Percent of Body Surface Burned.

(1) An early estimate of the percent of total body surface (TBS) burned is of great importance in determining the amount of fluid replacement necessary to prevent shock and in managing mass casualties. Usually, first degree burns are not included in this estimate. For practical purposes, especially in an emergency situation. second and third degree burns are considered to have the same effect when estimating the percent of body surface burned for fluid replacement purposes.

(2) The percent of TBS is estimated by using the rule of nines (fig. 8–26). The total body surface is divided into the major anatomic parts, each representing approximately 9 percent or multiples of 9 except for the perineal area. The head and neck represent 9 percent; each arm including hand, 9 percent; the anterior trunk, 18 percent; the posterior trunk, 18 percent; each leg including foot, 18 percent; and the perineum and external genitalia, 1 percent. Proportionate areas of these parts may be estimated.

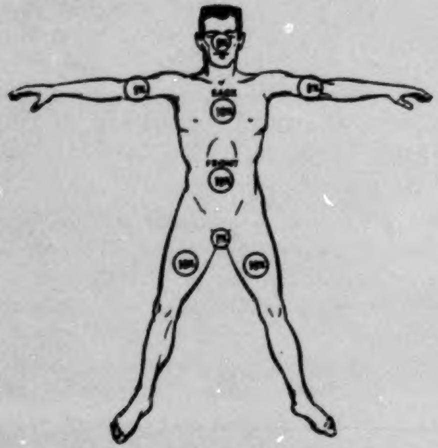


Figure 8–26. Rule of nines for estimating body surface burned.

8–32. Pathology in Second and Third Degree Burns

The pathologic process in second and third degree burns consists of three phases, as follows:

a. Phase 1. In the first phase of a burn, there is always some destruction of the skin, which results in a loss of plasma In second degree burns, there is a temporary loss of plasma in the form of edema fluid and a permanent loss through blister fluid or through weeping burned surfaces. Because of the loss of plasma, the local vascular mechanism is affected in the burned area. Excessive permeability and blood stagnation in the involved and adjacent capillaries occur immediately after the injury and cause plasma to seep into surrounding tissues. This exudate rapidly infiltrates these tissues and gives rise to widespread edema. Edema (collection of fluid) begins to develop at the time of burning and is evident within a few hours. It continues for 2 or 3 days. Excessive capillary permeability is also responsible for the large amount of plasma lost through damage of the skin. In second and third degree burns, particularly the latter, there is an appreciable destruction of red blood cells.

b. Phase 2. The second phase of burns begins, as a rule, on the third day after injury, with a reversal of the phenomena just described. The coagulum which forms on the surface of second degree burns reduces further surface losses. Edema fluid is now absorbed from the injured site into the blood stream. Finally, the arteriocapillary circulation, which was first distributed by vasodilation and then by vasoconstriction, returns to normal. The source of the exudation therefore dries up spontaneously. The eschar which forms on second and third degree burns reduces surface losses.

c. Phase 3. In the third phase of a burn, infection develops. Second and third degree burns are wounds and are subject to contamination from the moment of their occurrence. The existence of any wound exposes tissues to infection from bacteria because of the contact of the wound with the environment. The injury is contaminated almost immediately—sometimes at the moment of occurrence as the patient falls to the ground. Emergency rescue measures, makeshift first aid dressings, careless handling, and personnel breathing on the patient's burns are all factors which lead to established infection.

8–33. Classification

For emergency treatment purposes, second and third degree burns are classified by severity as minimal, moderate, and extensive, depending upon the percent of body surface burned:

Minimal burn	5–20 percent
Moderate burn	20–40 percent
Extensive burn	over 40 percent

8–34. The Mass Burn Situation

If disaster produces mass burn patients on a scale that overwhelms the existing medical capability, emergency and subsequent treatment procedures for the burn patients will, of necessity, be different from that accorded the individual burn patient under ideal treatment conditions. In a mass burn situation, patients with burns that run the gamut from superficial reddening of the skin to deep charring or amputation of parts may be expected. Those with superficial reddening require little or no treatment; those with deep charring may die despite heroic efforts.

a. Treatment of the Patient with Minimal Burn. If the patient's airway is obstructed, he is treated and managed according to the severity and persistence of obstruction. If there is no obstruction of the airway, or if obstruction is relieved by nonsurgical means (positioning or clearing the airway) the patient is given minimal treatment and released from medical care to perform work elsewhere or to receive "buddy care" at the hands of a friend. Release is made with the full realization that many such patients will return later to a medical facility for further treatment after the initial emergency has passed. If possible, patients with 5- to 20-percent TBS should receive the following treatment as a minimum:

(1) *Assurance.* The patient should be assured that despite his pain, his chance for survival (if he is otherwise healthy) is excellent, that all treatment possible under the circumstances is being given to him, and that he may expect to see others more seriously burned performing useful tasks during the emergency.

(2) *Dressings.* Dry dressings should be applied to burns of any area except the face or perineum. If dressings are in short supply, the needs of the moderately burned should be supplied first.

(3) *Ointment.* In the mass burn situation and especially in the absence of analgesic agents and dressings, sulfamylon or other bland, nongreasy ointments may be applied. If none are available, the burn wound should be covered with sterile or clean material to decrease exposure to air and resulting discomfort. If possible, aseptic technique is used in applying the ointment; otherwise, a clean technique is used.

(4) *Fluids and electrolytes.* If the patient is able to take and retain fluids by mouth, sodium chloride and sodium bicarbonate (table salt and baking soda) should be given as follows to help maintain the electrolyte balance of the body:

(*a*) Dissolve one package (4.5 grams) of sodium chloride-sodium bicarbonate mixture in 1 quart or liter of cool or cold water; or dissolve 4 Army-issue salt tablets (½ teaspoonful of loose salt) and 2 issue sodum bicarbonate tablets (¼ teaspoonful of baking soda) in the water. A quart jar, canteen, or a 1-liter infusion bottle that formerly contained normal saline or glucose may be used. Crush salt tablets for faster dissolving.

(*b*) Have the patient sip the solution, slowly at first, then increase the rate so that he will have consumed the entire quart (or liter) of solution within 24 hours. Do not give the solution if it is not cool or cold. Warm salt water is unpalatable and often causes vomiting. If patient is nauseated or vomiting, do not insist that he drink the liquid, but have him keep it available to sip as nausea subsides.

(*c*) Give additional amounts of the sodium chloride-sodium bicarbonate mixture when needed by the patient, depending upon the degree and extent of the burn. Other fluid should be given to maintain metabolism and hydration.

(5) *Rest.* The patient should be allowed to rest until it is assured that shock has been prevented or corrected.

NOTE

Antibiotics are withheld from these patients until it is assured that the needs of the moderately burned have been or can be met. The infection that the minimally burned patient group may develop is not expected to be immediately life-endangering, especially if the patient can be treated at a later time and if his nutritional level is maintained near normal. It is a risk that must be taken, a price that must be paid, if the chance to survive is to be given to the most people that are injured. As antibiotics become available for this group, patients with third degree burns should have first priority.

b. Treatment of the Patient with Moderate Burns. The outlook for patients with moderate burns is good if prompt treatment of a lifesaving nature is provided. The factors of immediate concern generally are shock and infection. However, if the airway is obstructed, it must be made patent (open) before other resuscitative and protective measures are taken.

(1) *Shock.* Shock in burns occurs within 2 to 10 hours after injury and lasts up to 48 hours. The degree of shock is directly related to the extent of the burned area and the depth of the burn, as these factors determine the amount of fluid loss. The first phase of one type of shock is characterized by the external loss of fluids from the affected area and the development of edema. The second phase is characterized by coagulation of the burned surfaces and the resorption of the edema fluid. During this period, the substances lost by the patient are chiefly the constituents of plasma; that is proteins, carbohydrates, electrolytes, and water. The goal of treatment in the first few hours after injury is the rapid replacement of lost fluids through the use of Ringers Lactate and colloids in an effort to maintain an adequate urinary output and control the shock. In view of the poor circulatory picture, morphine by the intramuscular route is not recommended. Analgesics may be given if they are available and can be tolerated.

(*a*) *Oral electrolyte solution.*

CAUTION

Great care should be exercised in administering oral fluids to burned patients. They may experience vomiting and possible aspirations which will complicate their early care.

Shock in burn patients may be prevented or reversed with the administration of the salt-soda solution by mouth. The patient's fluid and metabolic requirements should be met as far as possible by the oral route; those which cannot, by the intravenous route.

(*b*) *Selection of intravenous replacement fluid.* When the burn occurs, red blood cells in the involved vessels are damaged, destroyed, or coagulated. This constitutes the extent of red blood cell loss. None leaks out through the burn with the plasma. Therefore, whole blood, even if it were available, is not the replacement fluid of choice during the early phase of treatment. Ringers Lactate, normal saline, glucose solutions, colloids, or serum albumin in injection water may be given as available and as necessary to meet the specific requirement of the patient.

(*c*) *Formula for fluid replacement.* While no hard and fast rule can replace good judgment in individual patient care, the formula below may be used as a guideline for estimating the patient's minimum fluid requirements for the first 24 hours following a burn:

Colloid	0.5 ml. x body weight in kilograms x percent TBS
Electrolyte	1.5 ml. x body weight in kilograms x percent TBS
Metabolic	2,000 ml. glucose (dextrose), 5 percent, in water.

Using this formula, the first 24-hour postburn fluid requirements of a patient weighing 70 kilograms (154 pounds) and having a 30-percent total body surface burn would be calculated as follows:

Colloid	0.5 x 70 x 30 = 1,050 ml.
Electrolyte	1.5 x 70 x 30 = 3,150 ml.
Metabolic	2,000 ml.
Total	6,200 ml.

(Note that the percent TBS is used as a whole number, not as a decimal.)

(*d*) *Administration of replacement fluid.* One half of the quantity estimated as necessary should be given in the first 8 hours and the balance at a uniform rate over the succeeding 16 hours. The glucose, being of less immediate importance unless the patient is grossly undernourished, should be deferred until after the patient has responded to electrolyte and colloid solutions. During the second 24 hours, the colloid and electrolyte requirements are roughly one half the amounts recommended for the first 24 hours; the normal metabolic requirement remains the same. After 48 hours, fluids should be supplied as far as possible by the oral route.

1. Measure the urinary output hourly. In the emergency medical treatment situation, the preferred method of collecting the urine is by means of a catheter inserted into the urinary bladder by way of the urethra and left in place to drain into a suitable container for measurement. If a catheter and a specialist experienced in its placement are not available, arrangements should be made to catch all the patient's urine in a suitable container for measurement. The catch method, which depends on periodic voiding by the patient, is not as reliable as the catheter method; however, it does provide a rough guide that is especially useful in judging a too-rapid rate of fluid administration.

2. Adjust the rate of fluid administration to insure not less than 30 ml. of urinary output per hour. If the output exceeds 50 ml. per hour, the rate of administration should be curtailed.

(2) *Infection.* Burns of the second or third degree are particularly susceptible to infection: first, because they are open wounds and, second, because the matter exuded through them is most favorable to the growth of many species of pathogens. To a greater or lesser extent, burns become contaminated with infectious organisms almost immediately after incurrence. The objective in controlling infection is to prevent further contamination and to prevent development of the pathogens already present.

(*a*) *Aseptic technique.* To the maximum extent possible, aseptic technique is employed in all manipulations of the patient. All constricting articles such as rings, bracelets, wristwatches, belts, boots, and leggings are removed, but the patient is not undressed. Cleansing and debridement of these wounds are left for the physician performing initial surgery. All exposed burns except those of the perineum and face are covered with dry dressings. Management of the sterile dressing supplies should be such that these patients have first priority among burn patients. If sterile dressings are not available, clean wrappings such as sheets, towels, or even plastic garment covers may be used to protect these wounds from further contamination. If no surgical masks or suitable masking materials are available, personnel must refrain from talking over or breathing on the patient, or coughing or sneezing in his vicinity. If available, sulfamylon ointment may be applied to burns that must be left exposed if pain in these wounds interferes with resuscitation. Other ointments may be applied to the burn wound as directed by the physician.

(*b*) *Chemoprophylaxis.* Systemic antibiotics must be given as available if serious infection is to be avoided. Penicillin may be used with these patients, but should be conserved until the needs of the group are met. In addition, an initial or a booster dose of an appropriate antitetanus preparation should be given as soon as it is available.

c. Treatment of the Patient With Extensive Burns. With the best of care and treatment conditions, only about 50 percent of these patients survive more than a few days. Under the limited medical capability envisioned during the first 72 hours after onset of a mass burn situation, survival rate among these patients is expected to be much lower. Diversion of medical resources to these individuals when their chance for survival is so limited adds tragedy to disaster because it deprives others less gravely injured of the treatment, care, and supplies which, if applied early and correctly, can help them back to health. The extensively burned patient, therefore, has no priority for replacement fluid, dressings, antibiotics, or time of personnel except for those few moments needed to give analgesics or other medications available for the relief of pain. Those who survive the emergency phase are then given treatment and care to the extent possible that is not detrimental to the welfare of patients in higher priority treatment categories.

d. Special Emergency Treatment for Regional Burns.

(1) *Respiratory tract.* A face burn of instantaneous origin such as that from a flash or flame is almost always accompanied by inhalation injury to the respiratory tract. This damage is caused by the inhalation of superheated air or hot, irritating gases, especially in a closed place. Early signs of inhalation injury include burned (singed) nasal hairs and redness of the linings of the nose and throat. After a few hours, other signs appear, including difficulty in breathing; bluish discoloration of the skin, lips, and nails; and the presence of fluid in the air passages. All of these latter signs point to hypoxia, which must be relieved immediately. Coma position (fig. 8-13) may be sufficient to relieve respiratory distress. If all or part of the fluid obstructing the airway is from replacement fluid being infused too rapidly, temporary stoppage or slowing of the infusion, together with the coma position, may clear the airway. If the patient's condition will not permit rapid clearance of the airway by these methods, an emergency surgical airway should be made without hesitation (sec. III).

(2) *Joints.* Burns that destroy the skin over joints may heal with contractures which will limit or prevent movement of the joints. Beginning with emergency treatment, the joints should be placed in the best position for function: the knee, flexe slightly (5° to 10°); the ankle, placed in the normal position for standing; the elbow, straight; and the hand, positioned for writing.

8-35. Mortality Among Burned Patients

As a practical matter, a burn of more than 20 percent of the body surfare endangers life. In addition, the patient's age influences the outcome of a burn; the old and the very young do not withstand burn injuries well. A burn of more than 30 percent is generally fatal to adults in the absence of adequate treatment. The outlook also varies according to the location of the injury. Facial burns are often accompanied by complications involving the eyes or the respiratory passages, and serious risk of infection accompanies burns of the perineum. Most deaths among burn patients during the first few hours or days after injury are attributable to shock. Some form of respiratory obstruction accounts for most other deaths during this early period. Pulmonary edema from burns about the face and neck or from inhalation of noxious agents, superheated air, or superheated vapor are prominent forms of respiratory obstruction. Gastrointestinal bleeding from a stress ulcer may account for some early deaths. Later mortality is almost always due to infection.

Section X. CARE OF SPECIAL WOUNDS

8-36. Head Wounds and Injuries

Basically, the head may be thought of as consisting of two major structures: the skull and the brain.

a. Skull. The skull is an essentially hollow structure. On the outside are the musculature, skin, and appendages of the face and scalp. The scalp and facial structures are attached to the bones of the skull by means of a thin, tough, fibrous sheath, the periosteum, which is intimately attached to the bones. Within the face are the structures of the mouth, nose, and pharynx. The largest hollow of the skull, the cranium, contains the brain. The envelopment of the brain by the cranium is complete except for the hole at the base of the skull through which the spinal cord connects with the brain. Small holes in the cranium through which cranial nerves and blood vessels pass are sealed by the cranial lining.

b. Brain.

(1) The brain is the primary organ of life and the chief component of the central nervous system, which consists of the brain and spinal cord and controls all activities of the body. The brain controls directly the functioning of the eyes, ears, face, heart, and respiratory apparatus by means of electrical charges passed between these structures and control centers in the brain by the cranial nerves. Interference with these control centers results in erratic behavior or cessation of function in the organs and structures they control.

(2) The brain lies very close to but not directly against the bones of the cranium, being separated from the cranium by the meninges and fluid. The outer surface of the brain is intimately invested with one of the meningeal membranes, the pia mater, which contains many small blood vessels. The cranium is lined with the dura mater, a tough, fibrous, relatively thick, meningeal membrane. Between the dura and the pia are (1) the thin subdural space, which contains a little fluid, (2) the delicate, net-like arachnoid membrane, and (3) the subarachnoid space filled with cerebrospinal fluid. This fluid, which is clear, salty,

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and very watery, bathes the spinal cord and the outer and certain inner surfaces of the brain, and is essential for life.

Section VII. CONGENITAL ANOMALIES

10-51. General

Some congenital anomalies cause death or permanent handicaps; others can be corrected surgically. Any part of the body may be affected. There can be a complete absence of a part or a malformation.

10-52. Malformation of Mouth and Palate

The most frequent of these malformations are cleft palate and harelip, the result of failure of the maxillary, premaxillary, and palatal processes to fuse. One may occur without the other, but they frequently occur together. Although these babies have excellent appetites, they have trouble in sucking and swallowing. They swallow large amounts of air, and need to be burped often. Surgery is the only treatment. A cleft lip can be operated on around the age of 3 months, but a cleft palate is not usually repaired until after the child reaches 2 years of age. Meanwhile the baby must be fed, and the parents must be taught how to feed him. No one method will work for all—some infants can use a special nipple (fig. 10-13), others must be fed by cup, or by medicine dropper with a rubber tip to prevent injury to his gums, and some require gavage.

NOTE

For infants with cleft lip repairs, medicine droppers with rubber tips or asepto syringes with rubber tips are used. For infants with cleft palate repairs, a cup or asepto syringe with rubber tip is used.

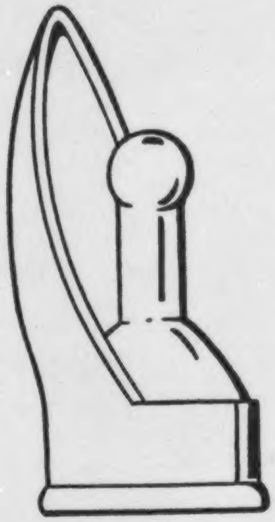

Figure 10-13. Cleft palate nipple.

Note: Page 196 has been omitted; However all material is included.

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CLEFT PALATE NIPPLE

Until a cleft palate is repaired, the cleft palate nippled may be used. The specialist inserts the nipple in the infant's mouth with rubber flange (cut to the size of the cleft in the palate) over the fissure area. This makes it possible to create a vacuum in the mouth and prevent aspiration.

MEDICINE DROPPER

NOTE

> The specialist will have to allow more time than the 20 or 30 minutes required to feed a normal baby by bottle.

Equipment

Sterile medicine dropper with rubber tip
or
Asepto syringe with rubber tip
Warmed formula
Bib
Protective covering for specialist

Procedure

1. Wash hands and insure that the infant is dry and comfortable. Mummy-wrap infant.
2. Add the formula to the medicine dropper or syringe.
3. Hold infant in sitting position.
4. Place the rubber tip on top and to the side of the tongue. Fluid should flow from the dropper slowly and in small amounts.
5. Allow the infant to swallow before giving more formula. If possible, do not permit sucking motions.
6. Burp frequently. If the infant can hold his head up strongly, sit him up, support his chest with one hand, and gently pat his back with the other. Otherwise, burp as described in paragraph 10–20*a*(2).
7. After feeding, put the infant in his crib on his right side with his back supported by a rolled infant blanket or small pillow.
8. Record results of feeding.

GAVAGE

Equipment

Small catheter or polyethylene gavage tube or No. 8 infant feeding tube
Syringe, 30 ml. or 50 ml.
Cup of water, 1
Small towel
Adhesive tape
Warmed formula

Procedure

CAUTION

> This can be a dangerous procedure for the inexperienced specialist and should be performed only under the supervision of the nurse or physician.

1. Using the catheter to be used for the gavage, measure the distance from the bridge of his nose to a point halfway between the xiphoid process (base of breastbone) and the umbilicus. Mark the tube.
2. Put the infant in a mummy restraint and put a small towel roll under his shoulders to hyperflex his neck.
3. Hold the infant's head with one hand to keep him still, and genly pass the catheter through his nose or mouth, depending on the physician's orders, until the preselected mark has been reached.
4. Stop and remove catheter at once if the infant chokes, coughs, or becomes cyanotic. Reinsert the tube only on the direction of the nurse or physician.
5. Secure the inserted tube to the infant's face with nonallergic type tape.
6. Depending upon local policy, the tube may be permitted to remain in place between feedings. If so, before each feeding, test the position of the gavage tube (to assure that it is not in the respiratory tract) by one of these methods—
   a. Attach a syringe to the gavage tube and withdraw a small amount of stomach contents. This insures that the tube is in the stomach.
   b. Place a stethoscope over the epigastric region, insert 0.5 ml. of air through the tube with a syringe, and listen to see if the air enters the stomach.
   c. Invert the gavage tube in a glass of water. If bubbles appear, withdraw the tube, as it is *not* in the stomach.
7. Attach a syringe barrel to the tubing.
8. Pour a small amount of warmed formula into the barrel.
9. Raise the syringe barrel about 8 inches above the *mattress* and let it flow by gravity slowly.
10. Just before the syringe empties, pinch the tube to prevent air from entering the stomach and add more formula to the syringe barrel. Do *not* overfeed, or the infant will vomit.
11. Follow feeding with a small amount of sterile water.

12. Remove gavage tube by clamping it, removing adhesive tape, and withdrawing quickly and smoothly.

PATIENT CARE TREATMENT AFTER SURGERY TO CORRECT MALFORMATION OF MOUTH AND PALATE

1. Aspirate nasopharynx to keep it clear.
2. Give adequate nutrition. Keep the suture line clean after feeding by using water from a cup or medicine glass.
3. Put the infant on his *back* and apply restraints to prevent him from rubbing the sutures.

CAUTION

> Close observation is necessary due to danger of aspiration. Head and shoulders should be elevated slightly.

4. Keep the suture line clean at all times, using sterile applicators for cleansing and drying and applying hydrogen peroxide. Clean *toward* the suture line to avoid putting tension on it.

10–53. Malformation of Trachea and Esophagus

The most common malformation is *atresia* (absence or closure of a normal body orifice) of the esophagus with tracheo-esophageal fistula. In the most common type of this particular malformation, the upper portion of the esophagus terminates in a blind pouch in the upper chest, the lower portion is a closed tube extending above the diaphragm, and the tracheo-esophageal fistula is connected with the lower section of the esophagus. An infant with this malformation wil have saliva flowing from his mouth because he can swallow only a small amount before the pouch fills. If the upper portion of the esophagus fills and there is overflow in the trachea, the infant may get pneumonia. Early surgical correction is necessary since the infant cannot take his formula because of instant regurgitation, choking, coughing, and cyanosis. This operation requires entry into the chest wall, so the infant will require water seal drainage (para 5–113), with the number of bottles determined by the physician. The specialist must change the child's position frequently, and coughing and crying are desirable. (The baby can be made to cry if the sole of his foot is tapped gently.)

10–54. Malformation of the Epiglottis

Among these malformations are those of the epiglottis and structures around it, collapsing larynx and trachea, and deformities of laryngeal cartilages or vocal cords. These are characterized by laryngeal stridor. Such infants need slow and careful feeding by small nipple or medicine glass and sometimes by gavage. There is contant danger of aspiration and of respiratory infections. Cysts and tumors of the throat are also common. Generally, such surgical patients need about the same nursing care as adults with laryngeal difficulties.

10–55. Hydrocephalus

This is a congenital anomaly where there is an increase of cerebrospinal fluid in the ventricles of brain which results in an increase in head size and pressure changes in the brain. The main symptom is the enlarging head size, but the scalp may also be shiny, the veins dilated, and the eyes crossed. The infant is irritable, vomits, has anorexia, and may have convulsions. The position of the patient without surgery must be changed frequently to prevent pressure sores and hypostatic pneumonia as the infant or child cannot turn himself because of the increasing size of the head. When the infant is turned, the specialist must support the head in the palm of one hand while rotating the head and neck together to prevent a strain on the neck. The specialist must also support the baby's head when lifting or feeding the baby. A calm quiet atmosphere is necessary when feeding the baby. Afterward he is put on his side and left undisturbed for a time after feeding. This child needs tender loving care like all other children. Do not neglect him.

10–56. Malformation of the Pylorus

The symptoms of pyloric spasm and pyloric stenosis (para 10–43) include projectile vomiting without any sign of nausea and with visible peristaltic waves traveling from left to right, and loss of weight, obvious abdominal bulges, and few stools. A child with this malformation is usually tense and needs a quiet, relaxed environment. Attempt to meet his needs for adequate warmth and for cuddling, particularly before and after meals. Do not excite him or handle him vigorously.

10–57. Intestinal Obstructions and Imperforate Anus

a. The most common anomalies of the bowels are intestinal obstructions—atresia (a complete block), stenosis (a partial block), volvulus (incomplete anchoring), and meconium ileus (meconium is so thick that it cannot pass through the intestinal tract). Most of these require surgical treatment. Even then, there is always danger of chronic nutritional disturbances and pulmonary disease.

b. An imperforate (no normal opening) anus is normally discovered when the baby is examined at birth, and surgery is done immediately. It is often accompanied by fistulas of the perineum, urethra, bladder, or vagina.

c. Infants with intestinal obstruction are in poor condition and suffer from dehydration before surgery. High fever must be reduced to at least 102° F (R). After surgery, the specialist takes and records the respiration and pulse rates every 15 minutes until reaction. If the child becomes cyanotic, the doctor is called, and these procedures are performed every 5 minutes. Afterward, rectal temperatures (except for operations on rectum or anus*) are taken every 2 hours if fever is over 102° F; otherwise, it is taken every 4 hours. If a vein on an arm or leg has been cutdown for continuous intravenous therapy, the arm or leg is put on a well-padded splint and wrapped securely. The child may need to be restrained by clove hitches and is usually turned every 2 hours. Intake and output are totaled every 8 hours and every 24 hours and recorded.

10–58. Spina Bifida

This is a congenital malformation that results in imperfect closure of the spinal canal, usually in the lumbosacral region. Because portions of the bony spine are missing, the membranes may protrude through the opening (called a *meningocele*). If the membranes *and* cord protrude, it is called a *meningomyelocele,* which is often accompanied by leg paralysis and some loss of control of the functions of the bowels and bladder. Surgery may be used for either but in a meningomyelocele, rehabilitation is needed to teach the child to use a wheelchair and to walk on crutches, when possible. This rehabilitation period also requires extensive nursing care to prevent infections and provide for correct positioning, careful skin care, and accurate observations and charting.

10–59. Congenital Cardiac Disease

This paragraph will list a few of the numerous congenital cardiac conditions, most of which were discussed in paragraph 10–38. If further informa tion is needed, an up-tp-date pediatric text should be consulted. In general, children adapt themselves readily to the limitations of their disease, and sudden death rarely occurs in these types of cardiac conditions. The main thing that must be guarded against is infection. The heart defects that are congenital are generally divided into cyanotic and noncyanotic.

a. Cyanotic. The children with cyanosis generally have a shunt that lets the venous blood travel by abnormal channels from right to left. Circulation through the lungs, which oxygenates the blood and gives it its red color, is bypassed. The types include—

(1) Tetralogy of Fallot (para 10–38*f*) whose symptoms are deep cyanosis, polycythemia (too many red corpuscles in the blood), and circulatory failure. A child with this defect is often below normal physically and is overdependent, insecure, and immature. The specialist must accept the child as he is.

(2) Transposition and displacement of the great vessels. There can be many faulty arrangements of the great vessels. This may be accompanied by pulmonic stenosis. In the Taussig-Bing syndrome, the aorta leads from the right ventricle and overrides the pulmonary artery. In Ebstein's malformation of the tricuspid valve, the abnormal valve is displaced into the right ventricle.

b. Noncyanotic. Among this group are the following: interventricular septal defect (one of the most common), atrial septal defect, patent ductus arteriosus, pulmonary stenosis, and coarction of the aoerta (a constriction of the lumen of the aorta at any point).

c. Postoperative Nursing Care. All nursing care for cardiac patients is under the supervision of a nurse. Immediately after surgery (during the first few minutes), the child is checked for vital signs, skin color, respiration, level of consciousness, and movement of extremities. The team will then carry out the surgeon's orders, which may include the following:

(1) Start oxygen therapy.

(2) Connect water seal bottle drainage.

(3) Connect the urinary catheter to a sterile closed drainage system.

(4) Prepare medications and intravenous fluids.

(5) Check vital signs every 15 minutes until

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* Axillary temperatures are taken on patients having rectal or anus abnormalities.

bleeding from chest tube stops and child has fully reacted.

Once these emergency care procedures have been accomplished, the team will review special problems with the surgeon. If a child has a tracheostomy, the team will verbally assure him that its members will be with him constantly.

d. Postoperative Nursing Care in Heart Survery With Hypothermic Anesthesia. In this type of surgery, the child is immersed in crushed ice or ice water until the body temperature is reduced to 86° F. After the incision is closed and the chest tubes secured, he is gradually warmed, usually by being wrapped in an electric blanket heated to 90° F. He should warm up 1° every 10–15 minutes. At this time, bleeding risk increases, so blood pressure and pulse are taken every 15 minutes after his temperature reaches 95° F. When the temperature reaches 97° F, the electric blanket is removed, and he is covered with a sheet and cotton blanket. He is placed in an oxygen tent with the usual rate of flow for the oxygen, but no icing unit, until his temperature reaches 98° F. Then the ice unit is inserted in the oxygen tent. After this, his temperature is taken every 30 minutes. In 2 hours, he will begin a fever which must be controlled. At 102°, cool sponges for 15 minutes at a time are used until the temperature is taken again. If it is still rising, aspirin is given. The specialist must watch for cyanosis, paleness, very dry mouth, bleeding in the chest, and shock. It usually takes about 14 days for the temperature to return to normal.

e. The Cardiac Patient. The cardiac patient is more apt to have pressure sores, so his skin must be kept clean and dry, and frequent changes of position must be made. Since there may be a reduction in urinary output, accurate intake and output records must be kept. Any change in pulse, temperature, respiration, color, or blood pressure must be reported at once. The specialist must also help the child accept his condition. This will be difficult as the child will be mentally upset and hate bedrest. The specialist must plan quiet activities.

10–60. Undescended Testes (Cryptorchidism)

Before birth, the testes of the male descend into the scrotum. If this does not happen and the testes remain in the abdomen, inguinal canal, or other structures, they are called undescended testes. Treatment is important to preserve fertility. When there is no hernia, endocrine therapy is usually tried. If unsuccessful, surgery is used. The specialist will notice that upon the child's return from surgery a rubber band is attached to the suture and anchored to the midthigh with adhesive tape. This is necessary to apply tension to the testicle to hold it in place, and it must be protected from any disturbance until its removal. The child will attempt to walk in a stopped position in order to relieve the discomfort. Encourage him to walk upright and remind him when he forgets. An indwelling catheter may or may not be used to prevent contamination of the suture line.

10–61. Other Malformations

a. Genitourinary Tract. There can be defective or displaced kidneys or exstrophy of the bladder.

b. Genital Organs. In females, the most common are imperforated hymen, incomplete epispadias, or adhesions of the clitoris or labia. In males,

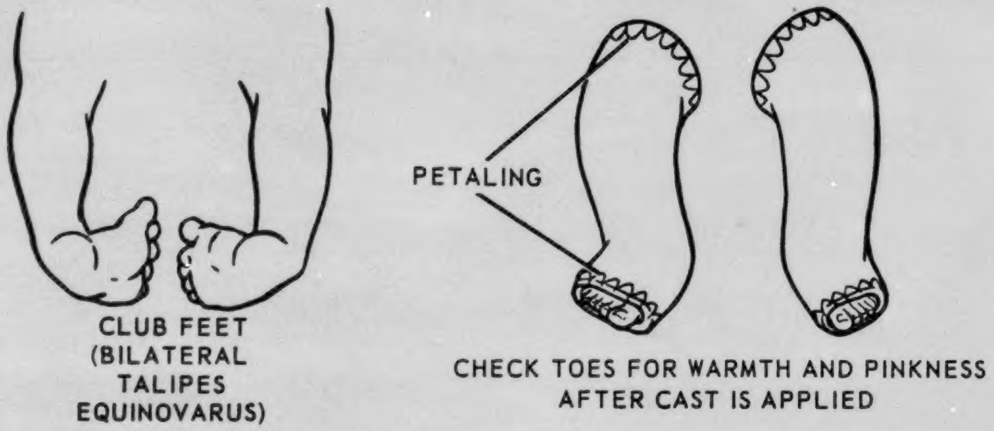


Figure 10-14. Clubfoot (inward) and one type of casting.

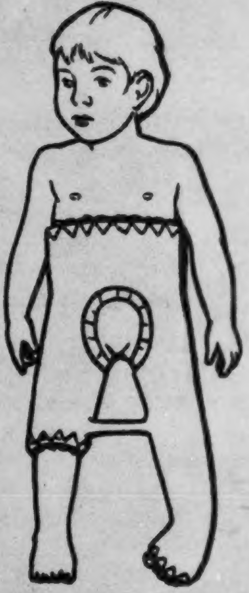


Figure 10-15. One type of unilateral clubfoot cast.

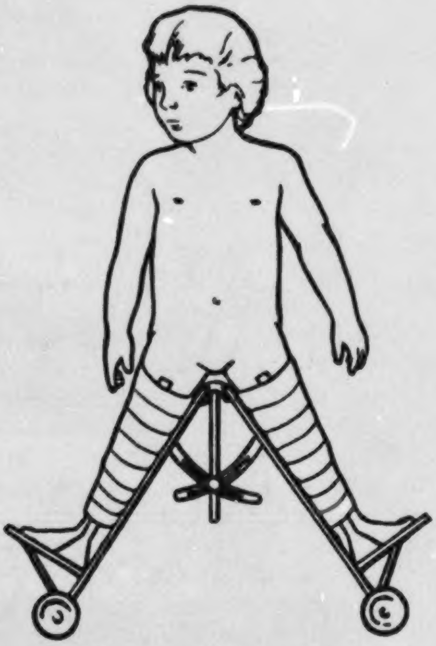


Figure 10-16. The Putti splint.

there can be malformation or abnormal location of urethral openings, phimosis, and hydrocele. An individual may also be afflicted with hermaphrodism—in which both ovaries and testicles are present—but this is rare. It is more common to see an individual possess the signs of one sex and have the gonads of the other.

c. Liver, Gallbladder, and Bile Ducts. There can be tumors of the liver, two gallbladders or none at all, and atresia of the bile ducts.

d. Skeletal System.

(1) Clubfoot is common. The foot may be twisted inward (fig. 10-14 Ⓐ) or outward (fig. 10-15). Two types of casts used are shown in figures 10-14 Ⓑ and 10-15.

(2) Polydactylism is an excess of fingers or toes.

(3) Syndactylism is a fusion of two or more fingers or toes.

(4) Congenital amputations are those where all or a part of an extremity is missing.

(5) Congenital dislocation of the hip is due to a malformation of the acetabulum which allows the femur's head to be displaced. If treatment begins before the child is a year old, a Putti splint (fig. 10-16) is usually used.

PUTTI SPLINT

Two boards are hinged together at one end with a wheel-like pulley at the opposite end. The hinged point is padded, and then waterproof material is placed over that. This waterproofing material must be washed and dried a MINIMUM of once a day.

Procedure

1. Place the child's perineum on the hinged point with a diaper over the perineum in loin-cloth fashion. The interior of the legs lie along the board.
2. Apply traction as ordered, starting above each knee. This traction extends to the pulley on each side.
3. Attach four straps to each leg: one above the ankle, one below and one above the knee, and one near the groin. Thread each strap through felt or sponge rubber to reduce pressure on the skin.
   - Frequently inspect the outside wrapping to be sure it is not telescoping (the bandage bunching over knee, ankles, or foot) and is dry; look at the feet for color and edema and touch for temperature; and test the traction ropes to see if they are taut.
   - When the child is supine, be sure there is a board under the mattress and a firm pillow under the buttocks to maintain alinement. To keep the child from falling out of the

crib (since both crib sides must be down), tie the *splint* on both sides to the lowered crib sides. Do not permit the patient's heels to touch the bed—use sandbags or rolled towels to elevate them.

4. Turn the child three times a day. Turning requires two people, one on each side of the crib.
   a. The child is pulled to the edge of the bed *away* from No. 1 specialist, who is to receive the child.
   b. No. 1 specialist slips one hand and arm under the patient just below the shoulders and uses the other hand to grasp the splinted leg that is the farthest away.
   c. No. 2 specialist, who is nearest to the child, places one hand under the buttocks and the other hand on top of his chest.
   d. The specialists lift together and turn the child in midair, being sure the splint does not touch the bed.
   e. The toes are checked to be sure they are not pinched or bent under.
   f. If the child is placed on his abdomen, a pillow is put under his chest and a thinner pillow under his abdomen near the hips to maintain alinement.
5. To place the child upon a bedpan, use extreme caution as the skin in this area is easily damaged.
   a. Release the top straps near the groin.
   b. If the patient is female, place one hand on the mons veneris and labia, and then push them back and up toward the abdomen. With the opposite hand on the Putti, push down and pull the point of the Putti up.
   c. If the patient is male, the top of the Putti rests behind the scrotum, so lift up the scrotum and penis toward the abdomen and push down and pull the point of the Putti up to place the child on the bedpan.
   d. Inspect the perineum when the Putti is released. Wash the perineum and genitalia with clear water each time the bedpan is used. (The skin is also inspected after a bath and the perineum and genitalia are thoroughly washed.)

NOTE: PAGE 203 HAS BEEN DELETED; HOWEVER ALL MATERIAL IS INCLUDED.

APPENDIX B

MOVEMENT TERMINOLOGY

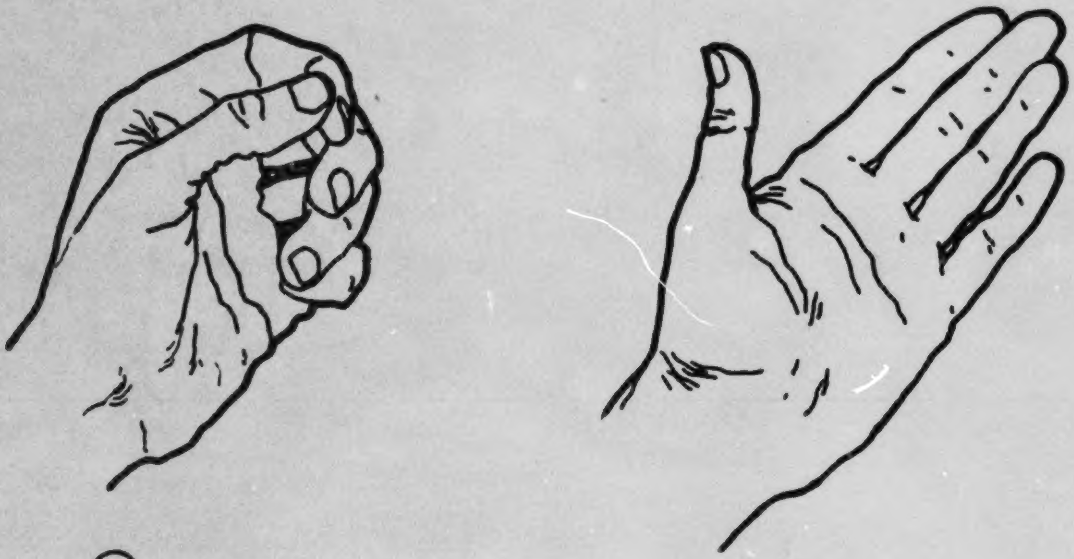
B-1. Motions of Joints

a. Joints of the body are capable of various motions according to the structures involved. Generally, when the joint angle becomes smaller than when in the anatomical position, it is in flexion. For example, when the elbow is bent, it is flexed. The opposite of flexion is extension. Thus, when the elbow is straight, it is extended. When a part is farther away from the midline than it is in the anatomical position, it is in abduction. *For example,* when the arm is raised out to the side, it is abducted. The opposite of abduction is adduction. A combination of these four motions—flexion, extension, abduction, and adduction—is called circumduction.

b. If a bone of a joint is capable of turning on its own long axis, the motion is called rotation. The motion of turning in toward the midline of the body is called inward or internal rotation, and the motion of turning out is called outward or external rotation. (The humerus in the anatomical position is in external rotation.) These basic motions of the body are illustrated in figures B-1 through B-11.

B-2. Anatomical Terminology

Paragraph 2-8 covers other terms used in anatomical terminology; paragraphs 2-19 and 2-20 cover other information on movements.



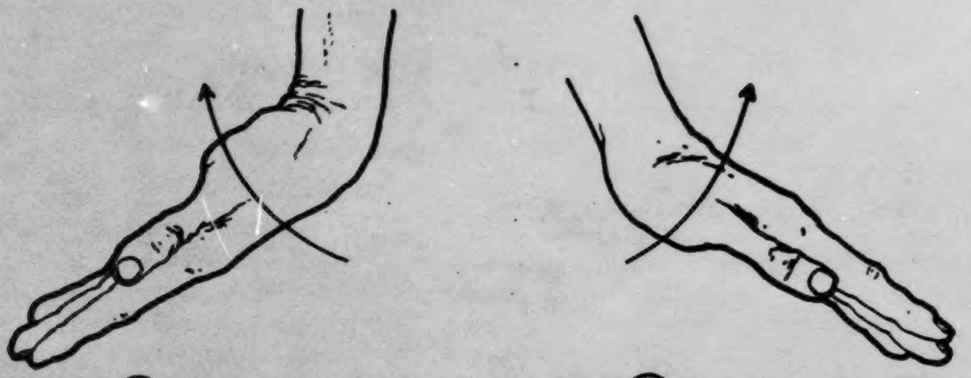
① FLEXION

FINGERS BEND FORWARD AT
METACARPOPHALANGEAL JOINTS
AND AT INTERPHALANGEAL JOINTS

② EXTENSION

FINGERS RETURN TO
STRAIGHTENED POSITION

Figure B-1. Finger motion.

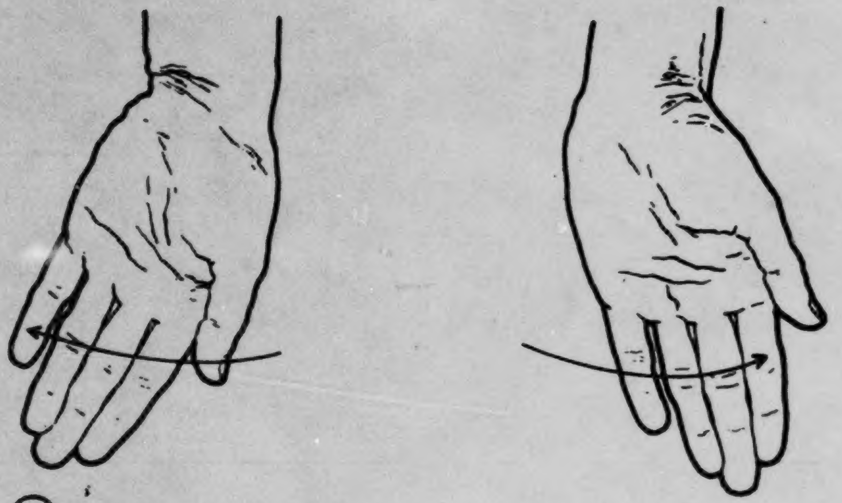


① FLEXION

HAND MOVES FORWARD.

② EXTENSION

HAND MOVES BACKWARD.



③ ULNAR DEVIATION

(ADDUCTION)
HAND MOVES TOWARD LITTLE
FINGER SIDE.

④ RADIAL DEVIATION

(ABDUCTION)
HAND MOVES TOWARD THUMB SIDE

CIRCUMDUCTION
(A CIRCULAR MOVEMENT – A COMBINATION OF THE ABOVE.)

Figure B-2. Wrist motion.

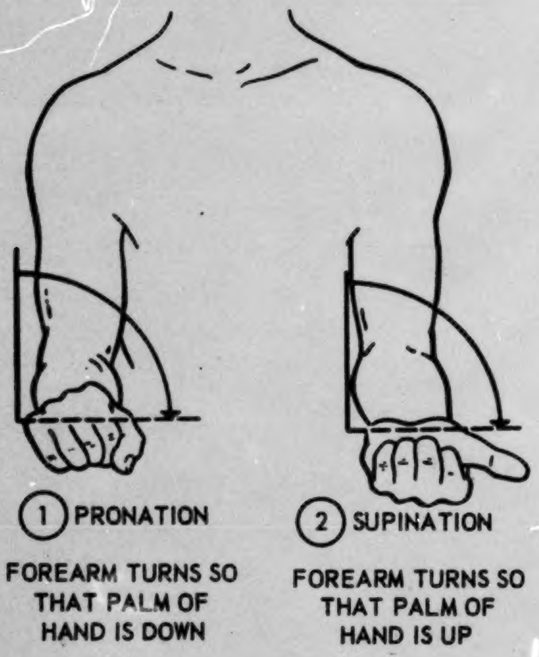

① PRONATION
FOREARM TURNS SO THAT PALM OF HAND IS DOWN
② SUPINATION
FOREARM TURNS SO THAT PALM OF HAND IS UP

Figure B-3. Radio-ulnar motion.

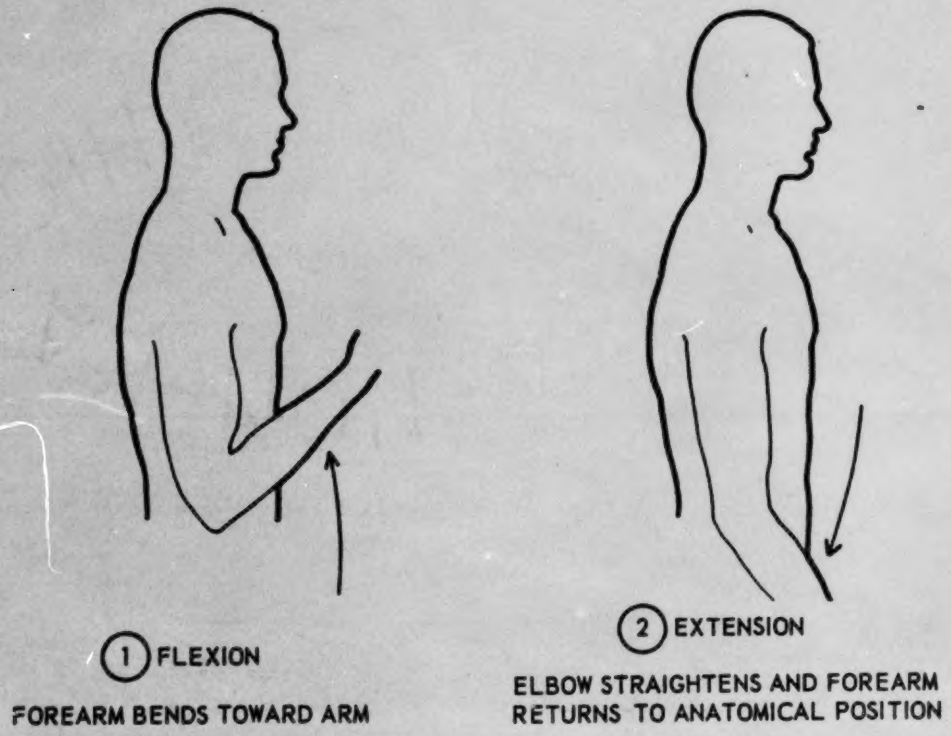

① FLEXION
FOREARM BENDS TOWARD ARM
② EXTENSION
ELBOW STRAIGHTENS AND FOREARM RETURNS TO ANATOMICAL POSITION

Figure B-4. Elbow motion.

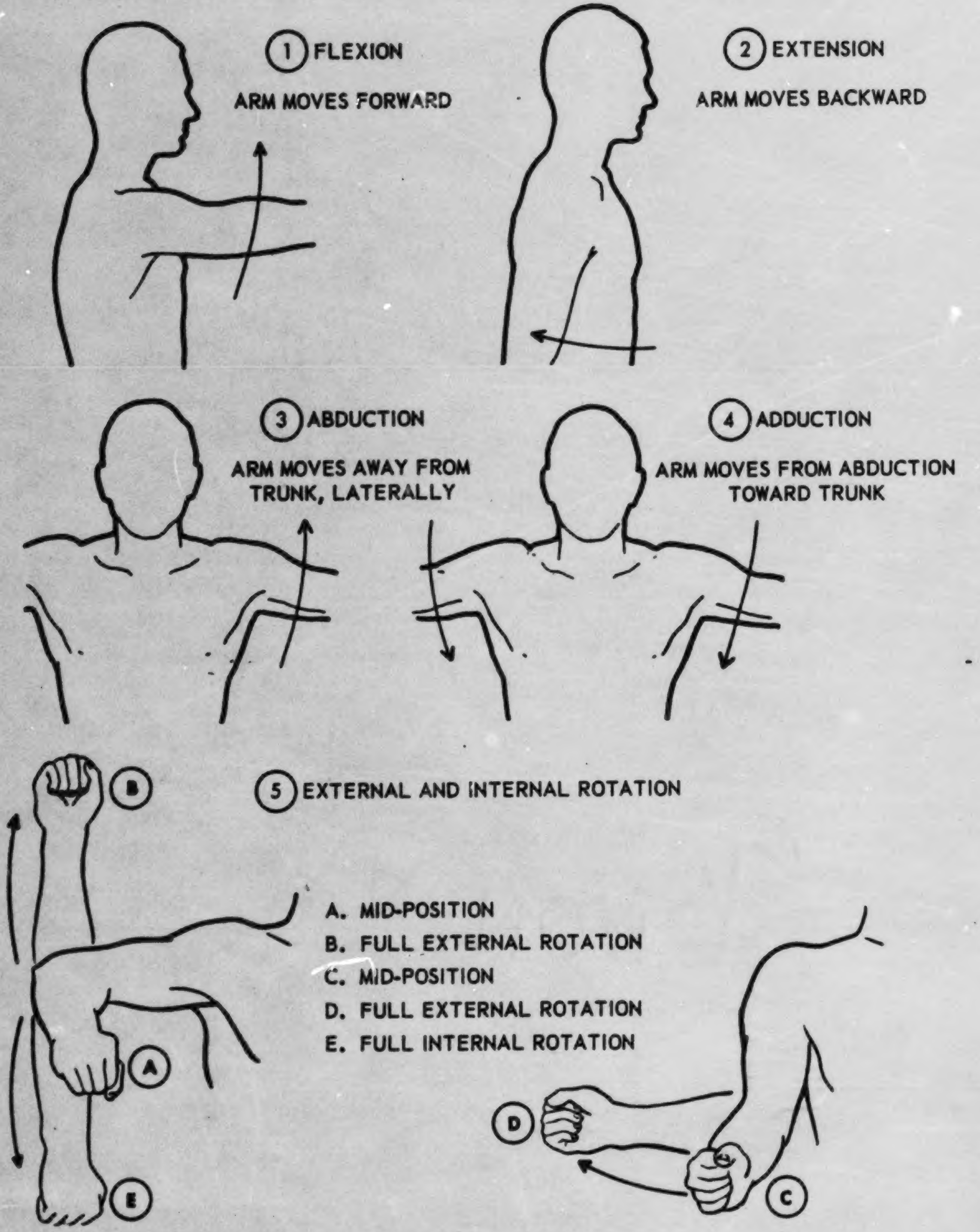
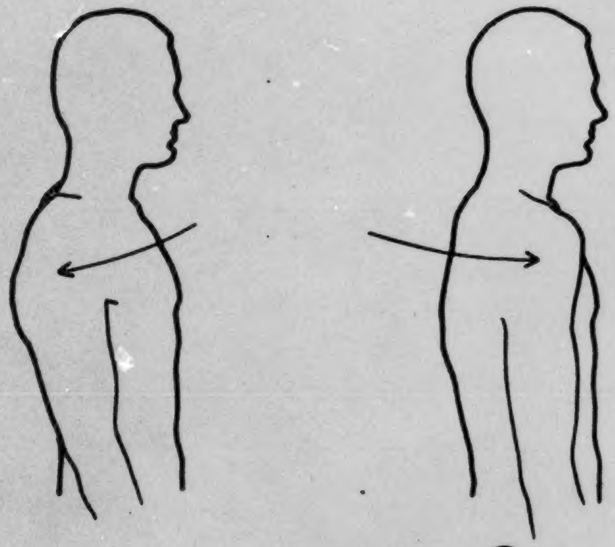

① FLEXION
ARM MOVES FORWARD
② EXTENSION
ARM MOVES BACKWARD
③ ABDUCTION
ARM MOVES AWAY FROM TRUNK, LATERALLY
④ ADDUCTION
ARM MOVES FROM ABDUCTION TOWARD TRUNK
⑤ EXTERNAL AND INTERNAL ROTATION
A. MID-POSITION
B. FULL EXTERNAL ROTATION
C. MID-POSITION
D. FULL EXTERNAL ROTATION
E. FULL INTERNAL ROTATION
B
A
E
D
C

Figure B–5. Shoulder motion.

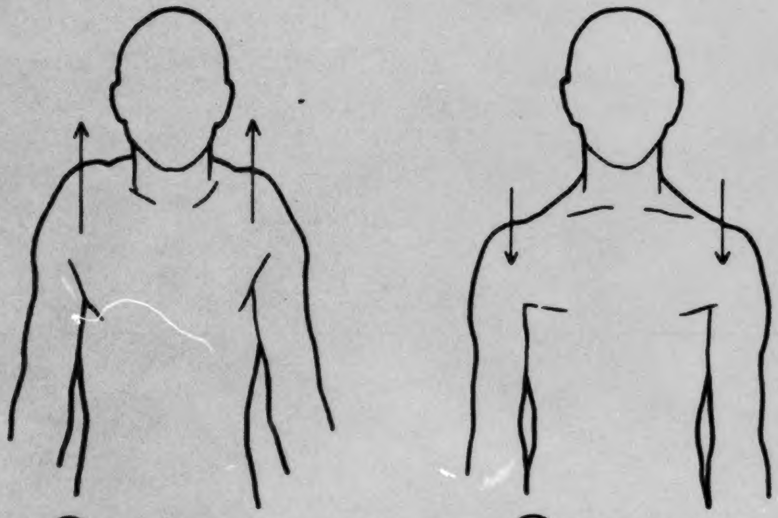


① ADDUCTION

(SCAPULAE MOVE TOWARD VERTEBRAL COLUMN.)

② ABDUCTION

(SCAPULAE MOVE AWAY FROM VERTEBRAL COLUMN.)



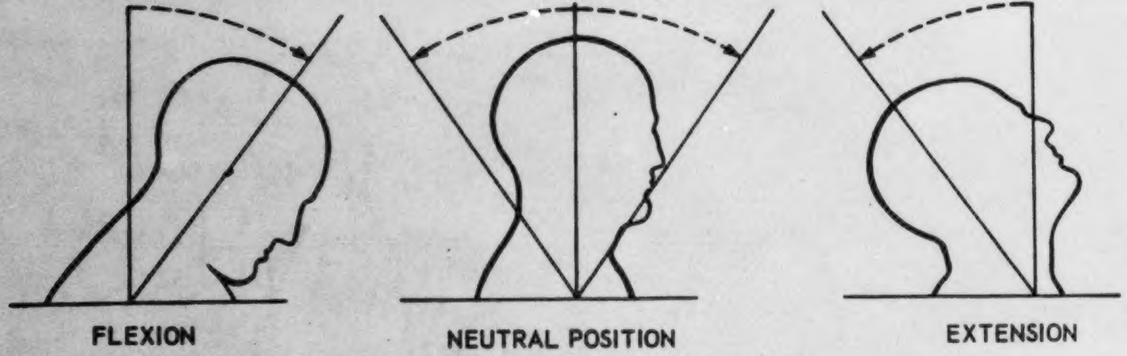
③ ELEVATION

(SCAPULAE AND CLAVICLES MOVE UPWARD.)

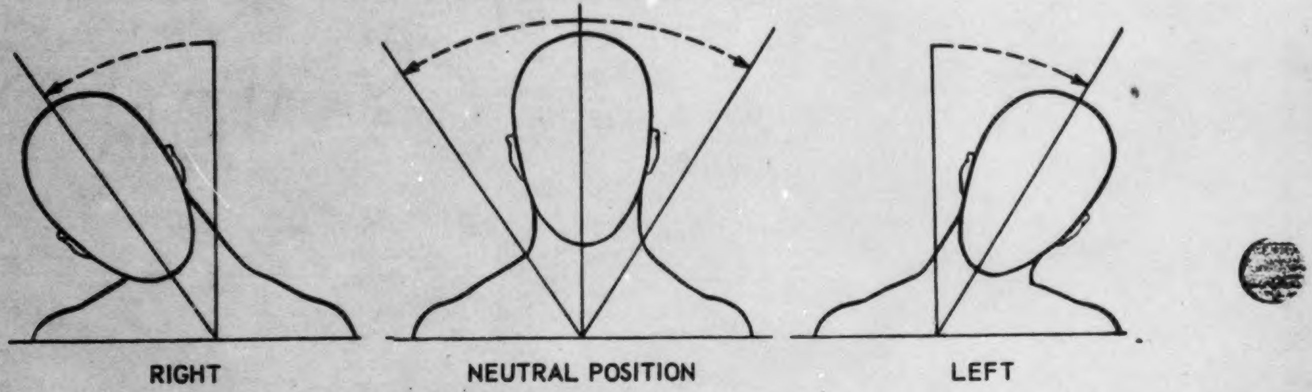
④ DEPRESSION

(SCAPULAE AND CLAVICLES MOVE DOWNWARD.)

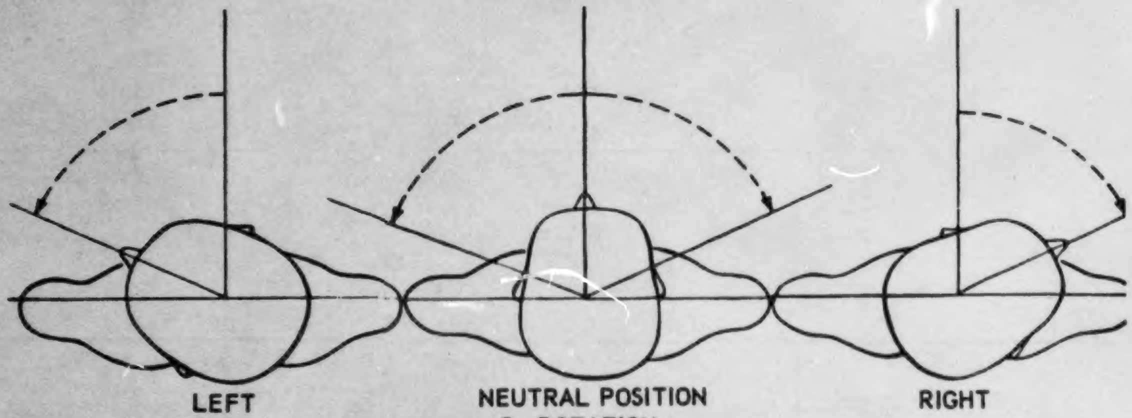
Figure B-6. Shoulder girdle motion.


FLEXION
NEUTRAL POSITION
EXTENSION

A. FLEXION AND EXTENSION
(OCCURS CHIEFLY IN THE LOWER CERVICAL AREA.)

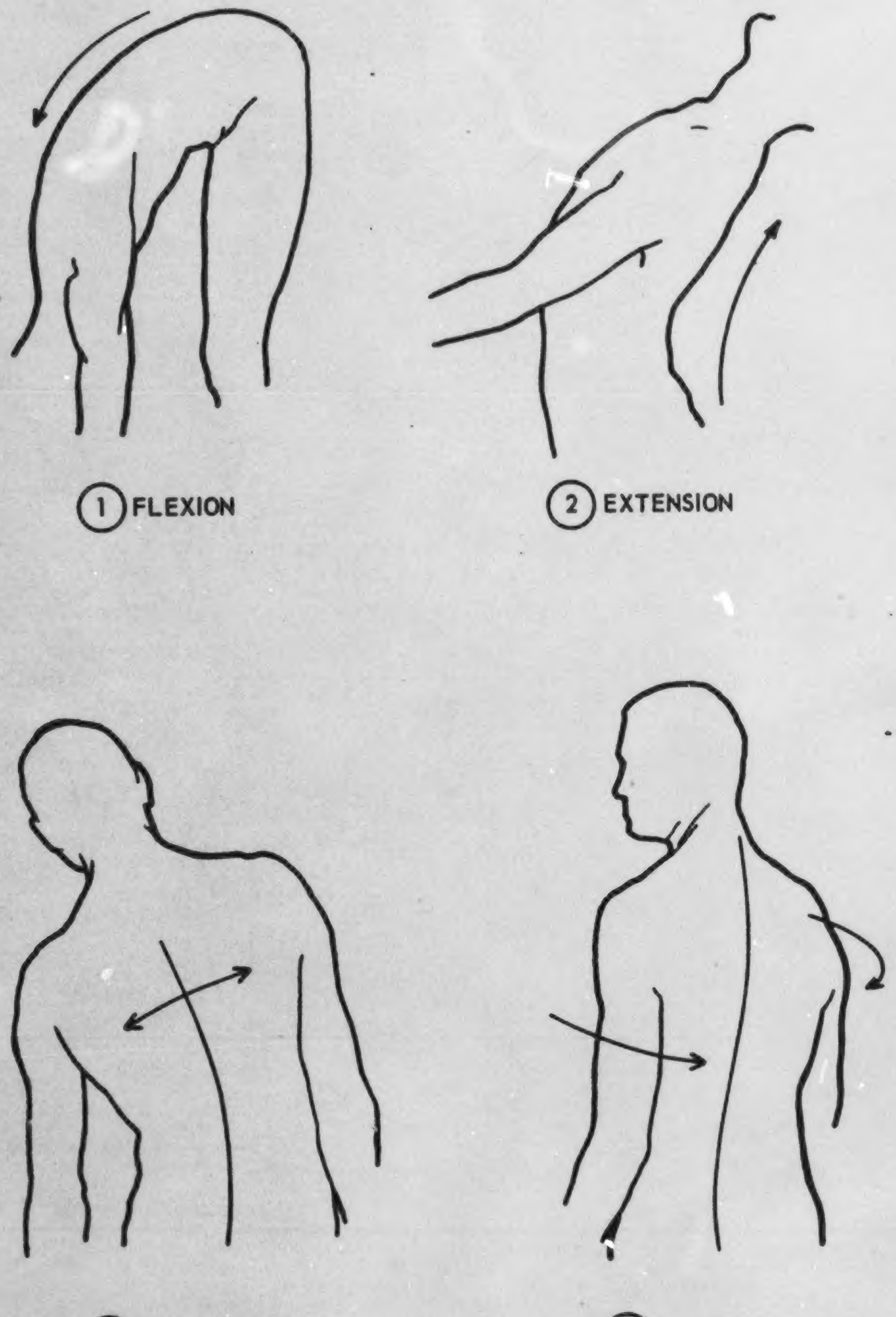

RIGHT
NEUTRAL POSITION
LEFT

B. LATERAL FLEXION
(OCCURS IN THE MIDCERVICAL AREA.)


LEFT
NEUTRAL POSITION
RIGHT

C. ROTATION
(OCCURS BETWEEN THE FIRST AND SECOND CERVICAL VERTEBRAE.)
HEAD TURNS TO RIGHT OR LEFT ACCOMPANIED BY SMALL
AMOUNT OF LATERAL FLEXION TO SAME SIDE

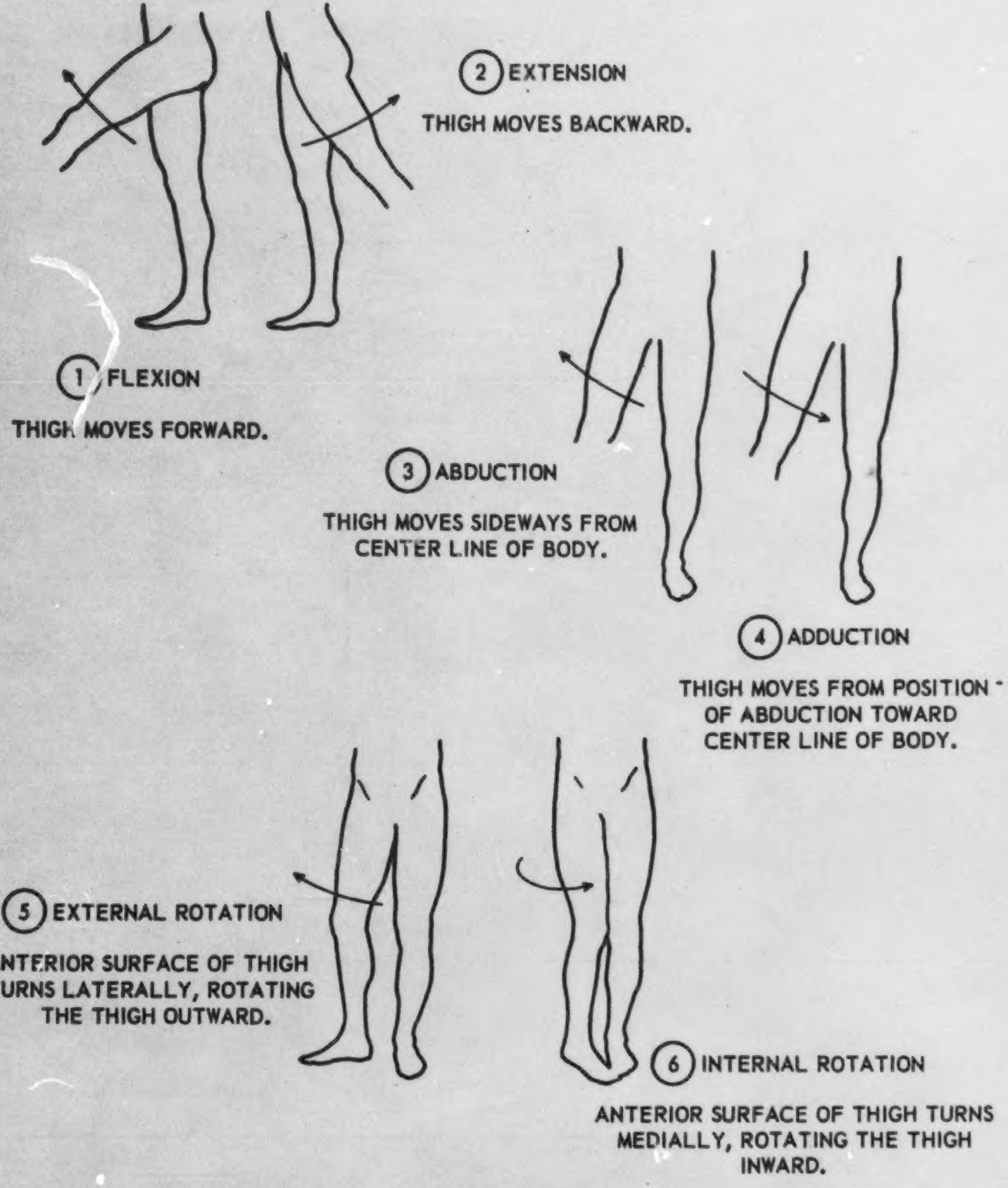
Figure B-7. Head and neck motion.



① FLEXION ② EXTENSION

③ LATERAL FLEXION ④ ROTATION

Figure B-8. Trunk motion.



① FLEXION

THIGH MOVES FORWARD.

② EXTENSION

THIGH MOVES BACKWARD.

③ ABDUCTION

THIGH MOVES SIDEWAYS FROM CENTER LINE OF BODY.

④ ADDUCTION

THIGH MOVES FROM POSITION OF ABDUCTION TOWARD CENTER LINE OF BODY.

⑤ EXTERNAL ROTATION

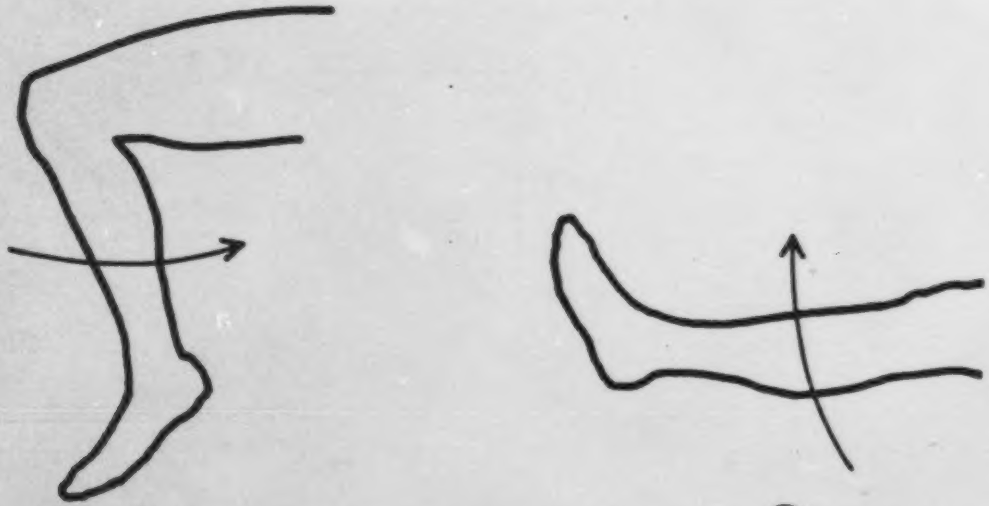
ANTERIOR SURFACE OF THIGH TURNS LATERALLY, ROTATING THE THIGH OUTWARD.

⑥ INTERNAL ROTATION

ANTERIOR SURFACE OF THIGH TURNS MEDIALLY, ROTATING THE THIGH INWARD.

(CIRCUMDUCTION, A CIRCULAR MOVEMENT, IS A COMBINATION OF FLEXION, EXTENSION, ABDUCTION, AND ADDUCTION.)

Figure B-9. Hip motion.



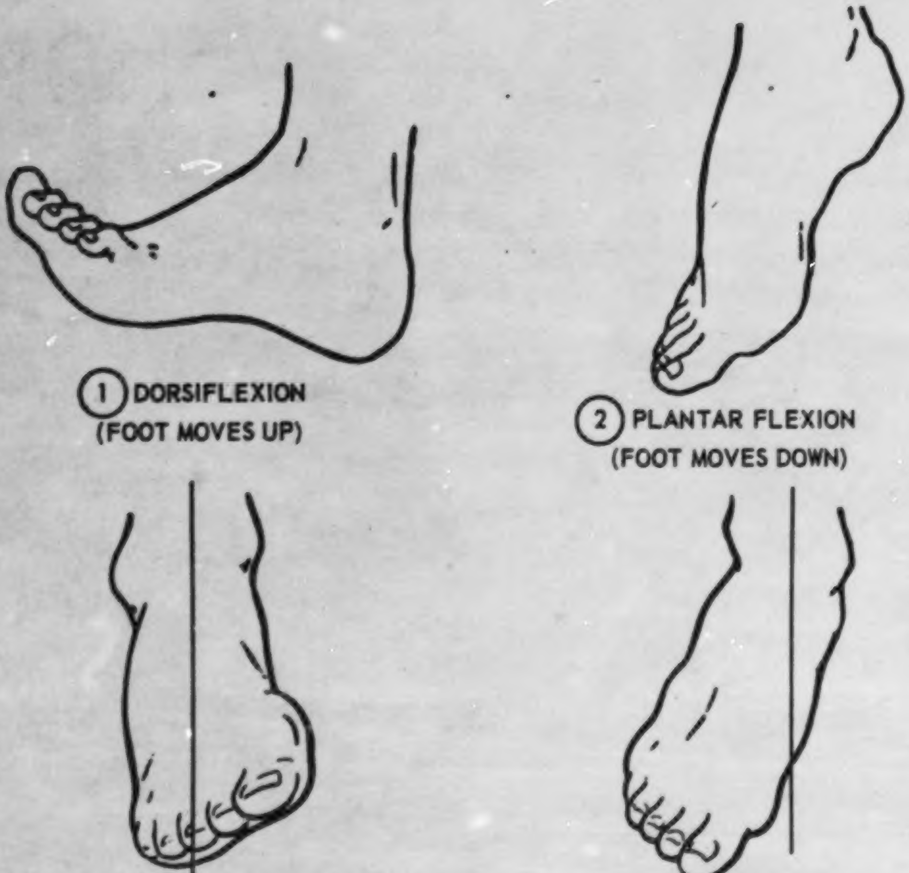
① FLEXION

THE KNEE BENDS

② EXTENSION

THE KNEE STRAIGHTENS

Figure B-10. Knee motion.



① DORSIFLEXION
(FOOT MOVES UP)

② PLANTAR FLEXION
(FOOT MOVES DOWN)

③ INVERSION
(SOLE OF FOOT TURNS INWARD)

④ EVERSION
(SOLE OF FOOT TURNS OUTWARD)

Figure B–11. Ankle and foot motion.

PART ONE

BASIC PRINCIPLES

CHAPTER 1

GENERAL

1. Purpose and Scope

a. This manual is intended to serve as a basic guide for the orthopedic specialist. It defines the role of the specialist as an assistant to the physician in the care of patients with diseases and injuries of an orthopedic nature. It provides background information on anatomy, physiology, pathology, wounds, surgery, asepsis and sterilization, and patient care as these subjects relate to the duties of the orthopedic specialist. It describes and illustrates some basic cast and traction techniques.

b. Appendix I lists Department of the Army and other publications referred to in the manual. Appendix II lists preoperative orthopedic procedure steps. Appendix III gives a sample SOP for the cast room.

c. The material presented herein is applicable without modification to both nuclear and nonnuclear warfare.

2. Users' Comments

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded to The Surgeon General, ATTN: MEDPT-TD, Department of the Army, Washington, D.C. 20315.

3. Role of the Orthopedic Specialist

The orthopedic specialist functions as an assistant to the physician in the care of patients with diseases and injuries of an orthopedic nature. He carries out the orders of the physician with great care as to details as they are given to him, realizing that he plays an important role in the successful treatment of the patient. The orthopedic specialist is expected to be proficient in the following areas:

a. He must know the details of human anatomy and physiology as it pertains to the bones, muscles, nerves, and blood vessels of the human body, and he must continually strive to improve his knowledge of these subjects.

b. The orthopedic specialist must know the principles of asepsis and wound dressing, so that he may deal intelligently with the wounds of patients who are sent to him by the physician. He must avoid contaminating these wounds at all times during the course of his duties. He must know how to prepare and store sterile supplies used in the treatment of these wounds.

c. The orthopedic specialist must know the principles of applying casts and the techniques of this skill, and he must be aware of the dangers which are caused by improperly applied or tight-fitting casts. He must master the method of making plaster molds of parts of the human body for use in the manufacture of appliances. He must know the proper use of traction apparatus and be able to follow the physician's orders accurately when traction is to be applied.

d. In all his relationships with the patient, the orthopedic specialist must remember that, as a professional member of a highly skilled professional team working with the physician, he must by his ability and actions reflect credit upon himself and that professional team.

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CHAPTER 2

ANATOMY AND PHYSIOLOGY

Section I. SKELETAL SYSTEM

4. General

The bony framework of the adult human body (figs. 1 and 2) is composed of 206 distinct bones of various shapes and sizes. In the child there are more, some of which fuse during growth. The points at which some bones come together are known as articulations, or joints, and with the action of muscles bring about movements of the body and its parts. Other bones, such as the bones of the skull, are joined together in a fixed position.

a. Bones support and give shape to the body, protect certain vital organs, afford attachments for tendons, muscles, and ligaments, and when acted upon by muscles act as joint levers by which movements may be accomplished.

b. The major divisions of the skeletal system are the skull, the vertebral column, the thorax, the shoulder girdle and the bones of the upper limbs, and the pelvic girdle and the bones of the lower limbs.

5. Bone Composition

Bone is a connective tissue in which calcium and other mineral salts have been deposited. These mineral salts normally constitute about 67 percent of the weight of the bone, but the amount increases as the body ages, causing the bones to become harder and more brittle. When the mineral salts or inorganic matter in bone are dissolved by means of dilute mineral acids, an organic substance called ossein remains. This substance, which is very flexible, can be bent and twisted without difficulty.

6. Bone Structure

a. Bone consists of a hard outer shell (cortical bone) and a spongy, porous inner part (cancellous tissue). In long bones, a cavity called the medullary canal extends the length of the shaft.

b. This cavity and the spaces in the cancellous tissue are filled with a substance called marrow. There are two types of marrow, yellow and red. Yellow marrow is composed chiefly of fat. Red marrow contains little fat, but is abundantly supplied with blood. In it are also found reddish-colored nucleated cells, called erythroblasts, from which red blood cells are formed, and nucleated cells, from which other blood elements are formed.

c. The ends and facets of bones adjacent to articulations are covered with a special type of cartilage called articular cartilage. This cartilage forms the articulating surfaces which enter into the formation of joints.

d. The parts of bones not covered by articular cartilage are covered with a thin vascular fibrous membrane called periosteum. The periosteum is essential for the nourishment, growth, and regeneration of bone. Since it has the power of generating new bone, it plays an important role in the repair of broken bones, as well as in the normal growth of bone.

7. Types of Bones

Bones may be classified according to their shape.

a. Long bones, such as the femur (bone of the thigh) (fig. 3) and the humerus (bone of the upper arm), have two condyles (ends) and a diaphysis (shaft) of cortical bone. The cortical bone is thickest in the middle where the bone is most slender and the stress the greatest. The shaft contains the medullary cavity.

b. Short bones are small and irregularly shaped and are made of cancellous tissue, ex-

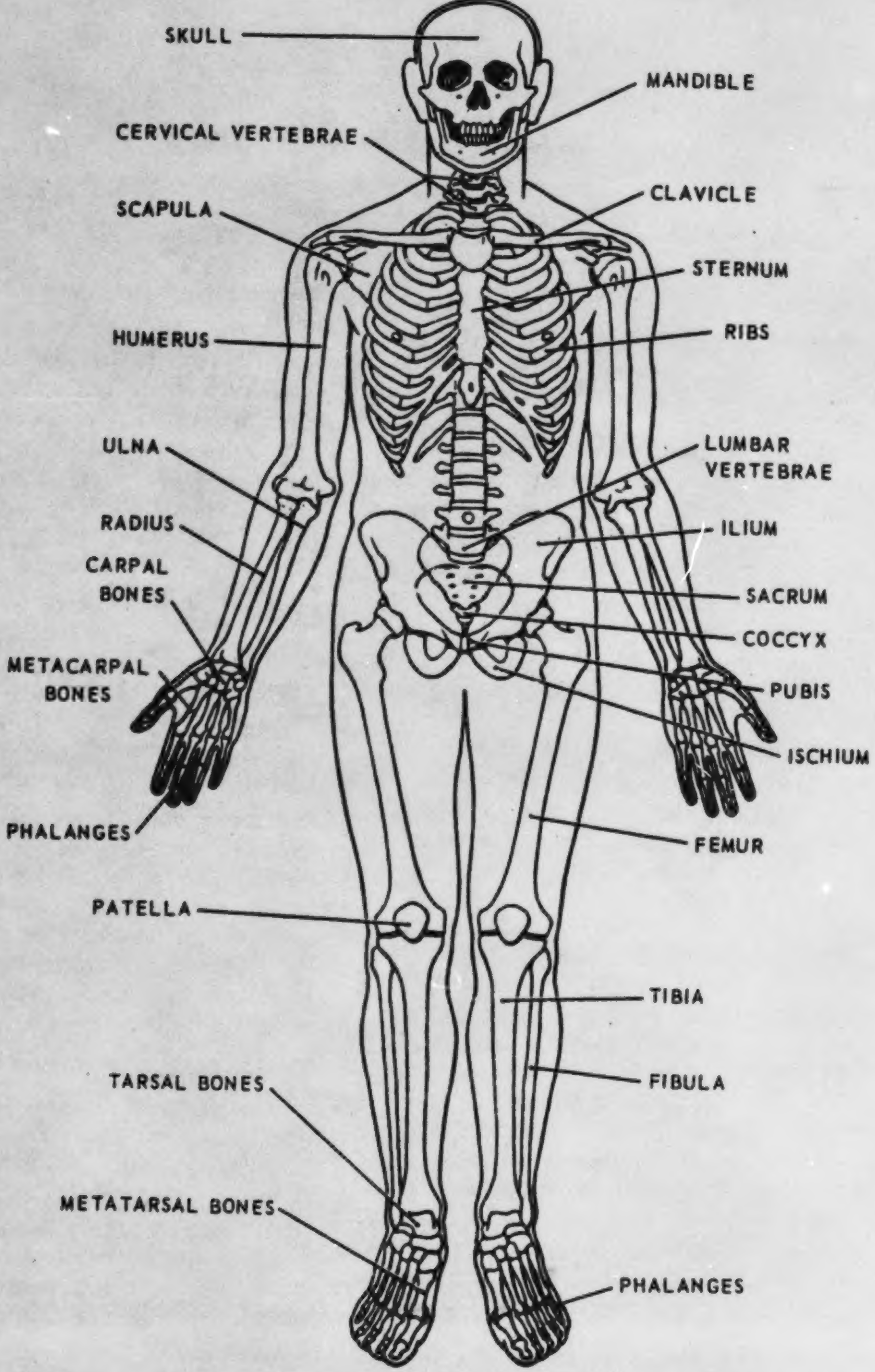

SKULL
MANDIBLE
CERVICAL VERTEBRAE
CLAVICLE
SCAPULA
STERNUM
HUMERUS
RIBS
ULNA
LUMBAR VERTEBRAE
RADIUS
ILIUM
CARPAL BONES
SACRUM
COCCYX
METACARPAL BONES
PUBIS
ISCHIUM
PHALANGES
FEMUR
PATELLA
TIBIA
TARSAL BONES
FIBULA
METATARSAL BONES
PHALANGES

Figure 1. The skeleton, anterior view.

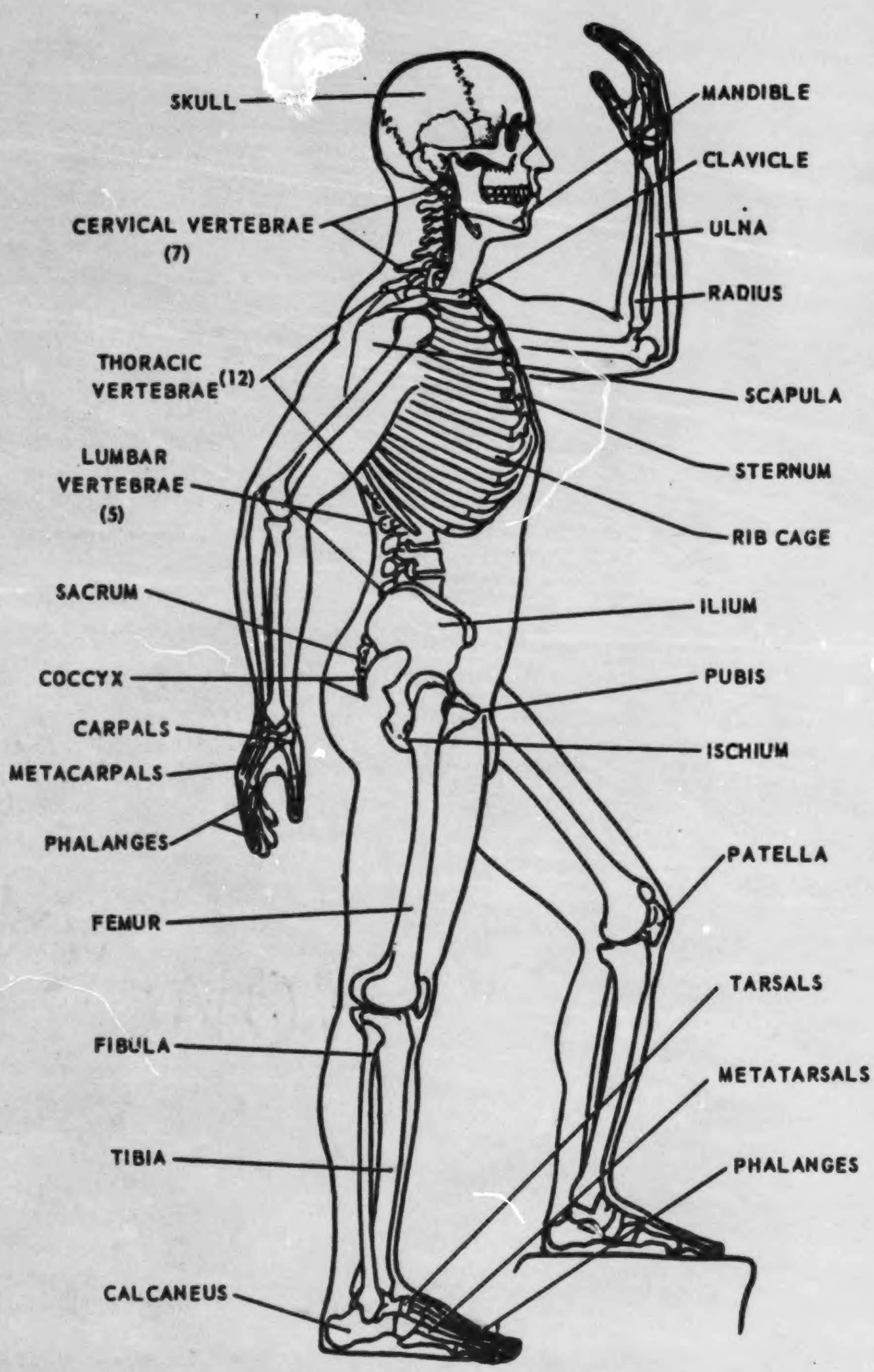

SKULL
MANDIBLE
CLAVICLE
CERVICAL VERTEBRAE (7)
ULNA
RADIUS
THORACIC VERTEBRAE (12)
SCAPULA
STERNUM
LUMBAR VERTEBRAE (5)
RIB CAGE
SACRUM
ILIUM
COCCYX
PUBIS
CARPALS
ISCHIUM
METACARPALS
PHALANGES
PATELLA
FEMUR
TARSALS
FIBULA
METATARSALS
TIBIA
PHALANGES
CALCANEUS

Figure 2. The skeleton, lateral view.

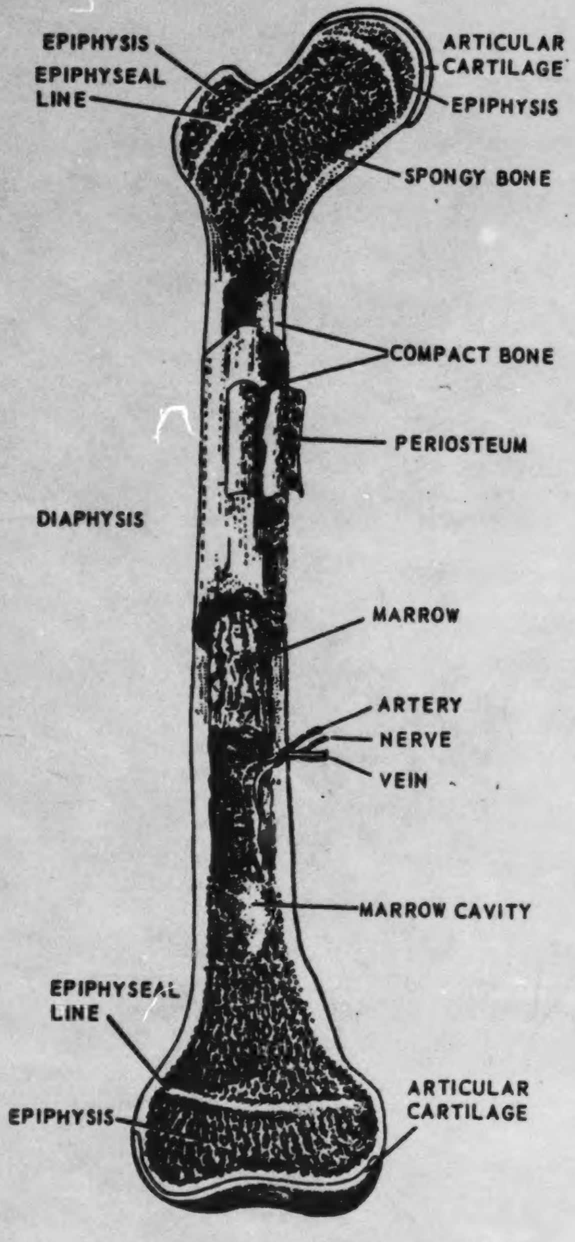


Figure 3. A long bone (femur).

cept for a thin layer of cortical bone covering the surface. The carpals (bones of the wrist) and the tarsals (bones of the ankle) are examples of short bones.

c. Flat bones are broad or elongated flat plates of cortical bone inclosing a variable amount of cancellous tissue. They provide extensive protection and broad surfaces for the attachment of muscles. Examples of flat bones are the sternum (breastbone), scapulae (shoulder blades), pelvic bone, and some bones of the skull.

d. Irregular bones cannot be placed in any of the above categories because of their peculiar shape. They consist largely of cancellous tissue with a thin layer of cortical bone covering the surface. Examples of irregular bones are the vertebrae.

8. Types of Joints and Their Motions

Joints are the areas where bones or cartilage join. They may be classified according to the degree of movement they permit (fig. 4).

a. Immovable joints, such as in the skull, are articulations between bones which do not provide for motion. The bones are held together by a thin layer of fibrous tissue or cartilage. There is usually some interlocking between the two bones.

b. Slightly movable joints, such as intervertebral joints, permit only a limited amount of motion. Between the bones forming the joints there is usually a fibrocartilaginous disc. The bones are held together by strong ligaments.

c. In *freely movable joints*, such as the knee joint, the ends of the bone are covered with cartilage, which serves as a cushion. A fibrous capsule covers the joint to bind it together, and the synovial membrane produces a fluid which acts as a lubricant for the joint. There are many types of freely movable joints (fig. 5).

(1) The *gliding joint* is one in which the flat surfaces of adjacent bones glide upon each other—for example, in the tarsal joints (except between the talus and navicular).

(2) The *hinge joint* is one in which the articular surfaces are molded to each other so as to permit forward and backward motion in only one plane, which is at right angles to its horizontal axis—for example, the elbow joint.

(3) The *pivot or rotary joint* is one in

which one bone pivots or rotates about another. The pivot joint rotates on its long axis. Example of a pivot joint is the atlanto-axial joint (cervical spine).

(4) The *condyloid joint* is one in which the convex, oval head of one bone fits into the concave surface of another—for example, the ankle joint. This type of joint is freely movable in vertical and horizontal directions but does not allow axial rotation.

(5) The *saddle joint* is one in which a concavo-convex surface articulates with a convexo-concave surface. The movement allowed by this joint is

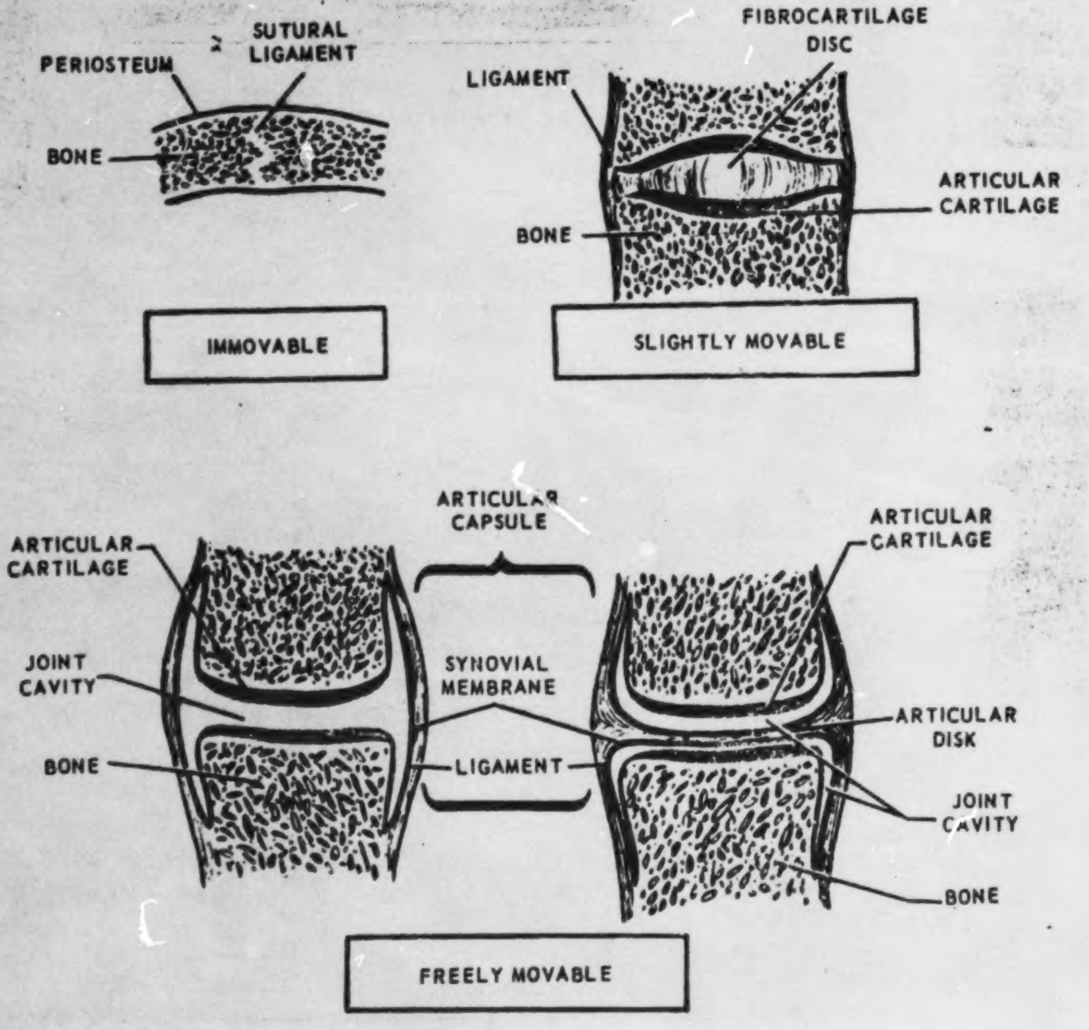

PERIOSTEUM
SUTURAL LIGAMENT
BONE
IMMOVABLE
FIBROCARTILAGE DISC
LIGAMENT
ARTICULAR CARTILAGE
BONE
SLIGHTLY MOVABLE
ARTICULAR CAPSULE
ARTICULAR CARTILAGE
JOINT CAVITY
SYNOVIAL MEMBRANE
BONE
LIGAMENT
ARTICULAR CARTILAGE
ARTICULAR DISK
JOINT CAVITY
BONE
FREELY MOVABLE

Figure 4. Types of joints.

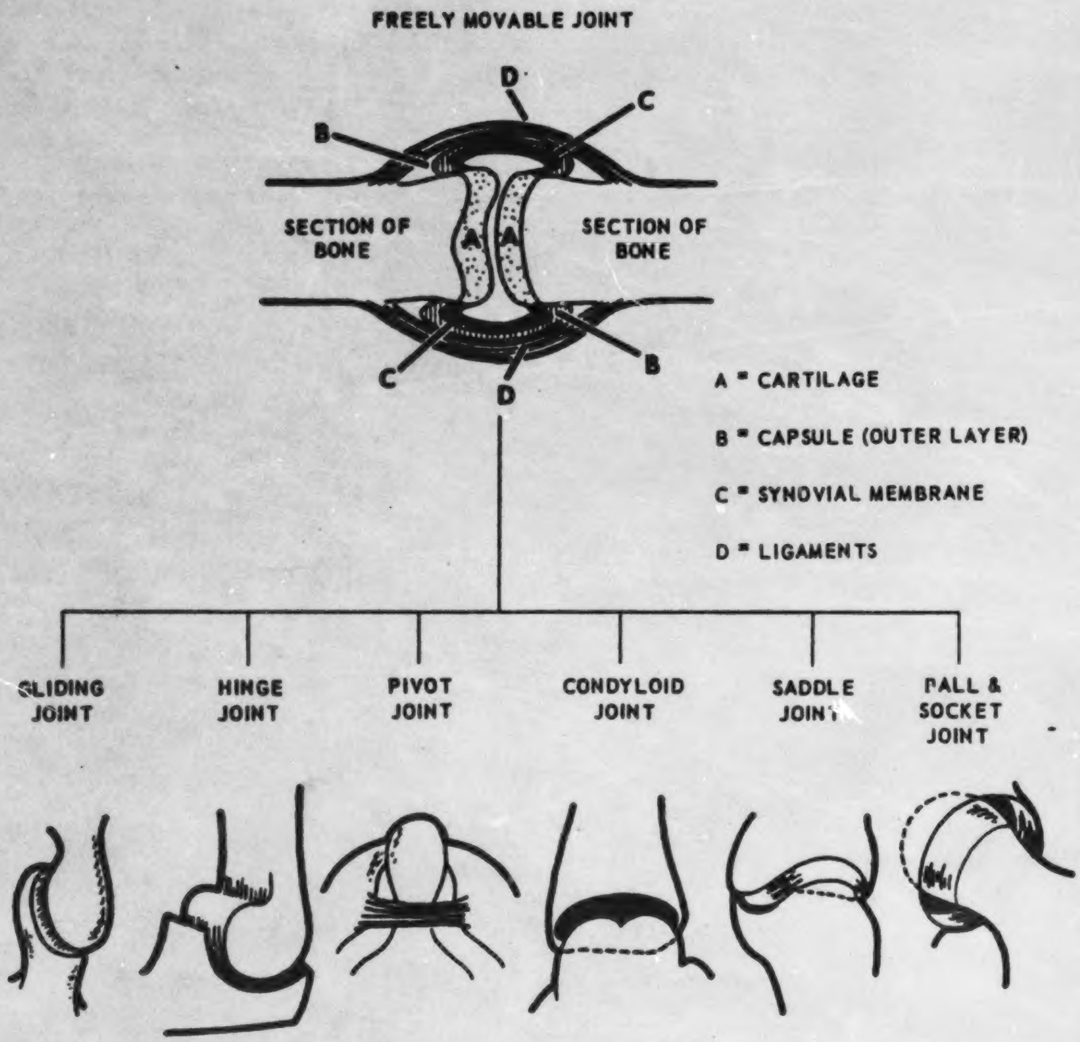

FREELY MOVABLE JOINT
D
C
B
SECTION OF BONE
A
A
SECTION OF BONE
C
D
B
A = CARTILAGE
B = CAPSULE (OUTER LAYER)
C = SYNOVIAL MEMBRANE
D = LIGAMENTS
GLIDING JOINT
HINGE JOINT
PIVOT JOINT
CONDYLOID JOINT
SADDLE JOINT
BALL & SOCKET JOINT

Figure 5. Types of freely movable joints.

similar to that of the condyloid joint. The carpometacarpal joint of the thumb (para 17*b*(3), fig. 18) is a saddle joint.

(6) The *ball and socket joint* is one in which the spherical head of one bone fits into a cuplike depression of another. This joint permits rotation around the central axis, as well as movement in any direction. The hip and shoulder joints are examples of the ball and socket joint.

d. Motion of Joints. The motions of joints of the different parts of the body are illustrated in figures 8, 9, 12, 13, 15, 16, 19, 20, 22, 25, and 28. For range of motion of joints, see TM 8–640.

9. Skull

The skull is composed of 21 bones, which are joined and move as one, and a freely movable bone, the mandible, which is the largest bone in the face. Eight of the 22 bones form the cranium and 14 of them form the face.

10. Vertebral Column
(fig. 6)

The vertebral column is the spine or backbone. It provides support for the trunk and the cranium and a protected passage for the spinal cord and the roots of the spinal nerves. It consists of 24 movable or true vertebrae and the fixed vertebrae (sacrum and coccyx).

a. True Vertebrae. The true vertebrae are named according to their location. Beginning at the top of the vertebral column, there are 7 cervical, 12 thoracic or dorsal, and 5 lumbar vertebrae. These vertebrae are irregular bones placed one on top of the other, like little blocks, with cartilage between them.

(1) *Typical vertebra* (fig. 7). The form of the individual vertebra varies at different levels. A typical vertebra consists of two basic parts—a *body* (anterior part) and a *vertebral arch* (posterior part). The space inclosed by these two parts of the vertebrae is called the *spinal canal,* a passage which incloses the spinal cord. Between every pair of vertebrae are two *intervertebral foramina,* one on each side, which provide passageway for the spinal nerves. The vertebral arch consists of *pedicles* (short and thick), *laminae* (broad plates), and *processes.* Two pedicles project backward to join two laminae. The laminae project backward from the pedicles. Three processes which act as levers for the attachment for muscles and ligaments spring from the arch, two *transverse processes* (one on each side) and a *spinous process* posteriorly. The spinous process can be felt in the middle of the back. Normally the spines can be counted either from the seventh cervical or the first thoracic vertebra,

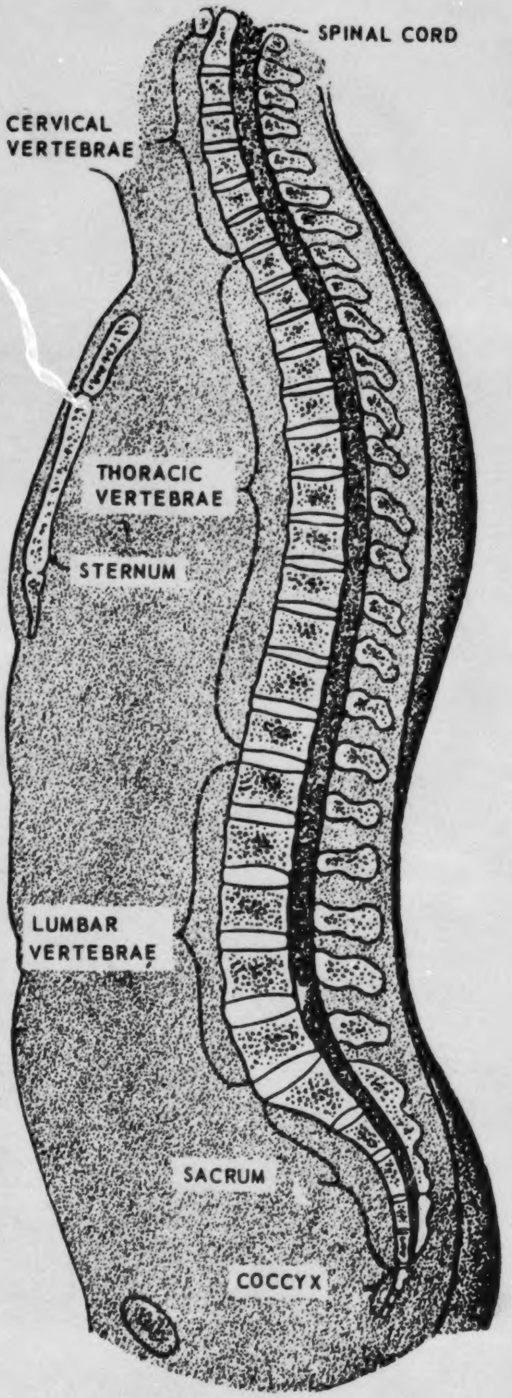


Figure 6. The vertebral column.

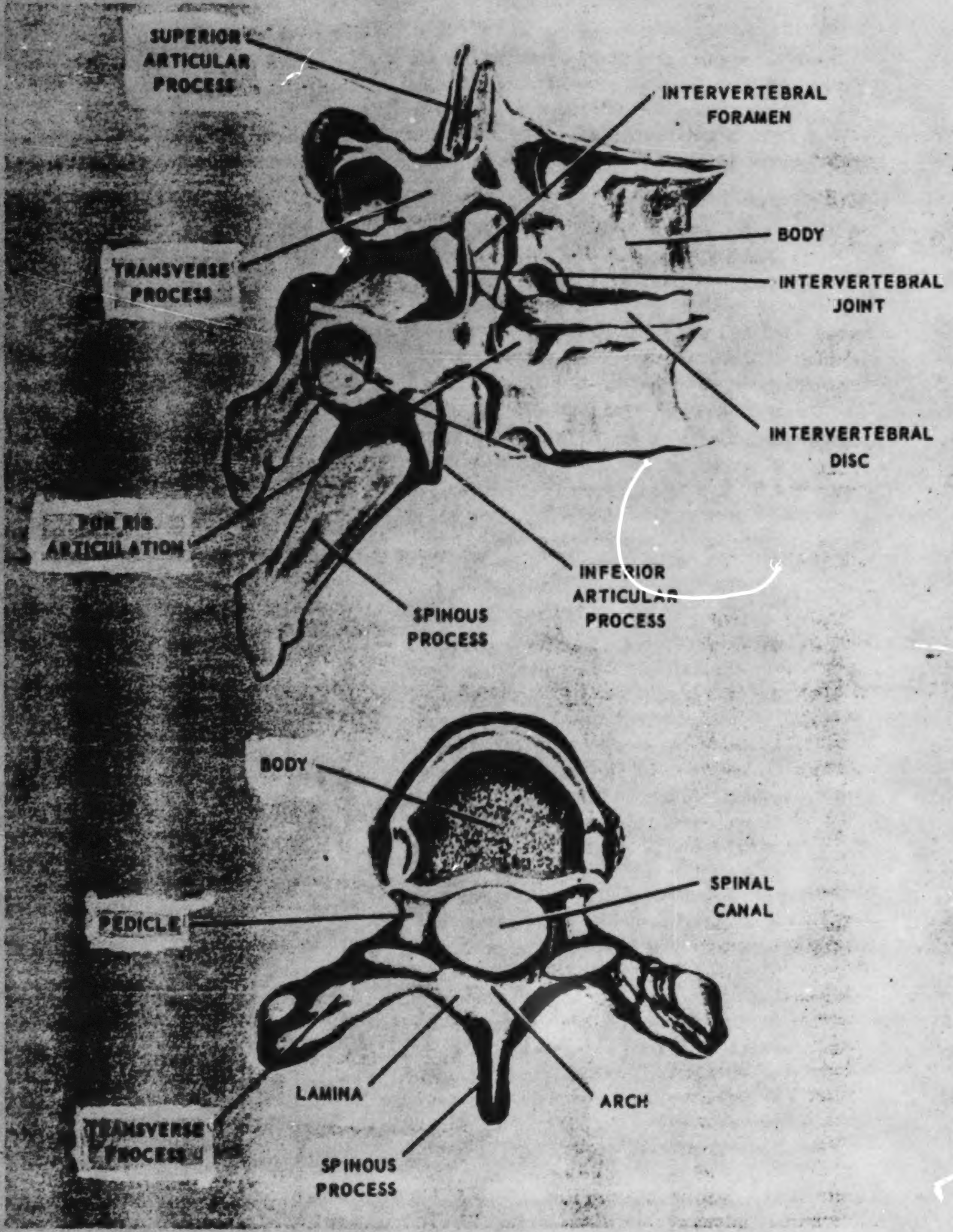

SUPERIOR ARTICULAR PROCESS
INTERVERTEBRAL FORAMEN
TRANSVERSE PROCESS
BODY
INTERVERTEBRAL JOINT
INTERVERTEBRAL DISC
FOR RIB ARTICULATION
INFERIOR ARTICULAR PROCESS
SPINOUS PROCESS
BODY
SPINAL CANAL
PEDICLE
LAMINA
ARCH
TRANSVERSE PROCESS
SPINOUS PROCESS

Figure 7. Typical vertebrae.

which are the most prominent parts of the spine when palpating or viewing the spines at the base of the neck. Occasionally the second cervical vertebra can be palpated. As a rule, however, from the skull to the seventh cervical vertebra the posterior spinous processes are obliterated by overlying muscle. Four *articular processes* also spring from the arch. Their ends are called facets, one surface of each being covered with articular cartilage. The two superior facets form two separate *intervertebral joints* with the inferior two facets of the vertebra above. Motion of the back takes place through these joints.

(2) *Intervertebral discs.* Between the bodies of the vertebrae are *intervertebral discs.* Each disc consists of a central, soft, pulpy, highly elastic substance of yellowish color, the *nucleus pulposus.* Normally, it is under pressure and is compressible but is held intact by a surrounding fibrocartilage ring called the *annulus fibrosus.* These discs act as shock absorbers and permit the bodies to bend on each other.

(3) *Ligaments.* The bodies of the vertebrae are held together by an anterior and a posterior *longitudinal ligament.* Between the laminae are the *ligamenta flava,* which serve to close in the space between the arches. The *supraspinal ligaments* connect the apices of the spinous processes. The *interspinal ligaments* connect adjoining spinous processes and meet the ligamenta flava in front and the supraspinal ligaments behind. Between the transverse processes are the *intertransverse ligaments.* Adjacent articular facets, which form the true joints, are covered by articular cartilage and are surrounded by synovial membrane and capsule. The vertebrae are fairly well anchored, and if a disturbing force is applied they usually break before the ligaments tear.

b. Fixed Vertebrae. The fixed vertebrae (the sacrum and the coccyx) are made up of vertebral segments that are fused in adult life.

(1) *Sacrum.* The sacrum is a large wedge-shaped bone which is composed of five fused and modified vertebrae. The anterior surface is concave and forms the posterior wall of the pelvis. It is perforated by four pairs of foramina (holes) for the passage of the four sacral nerves. The posterior surface is rough for the attachment of muscles and ligaments, whereas its lateral masses present large articular surfaces for the articulation with the ilia. The sacrum is suspended by the sacroiliac ligaments between the two iliac bones and serves as a base for the support of the presacral spine. It articulates above with the last lumbar vertebra and below with the coccyx.

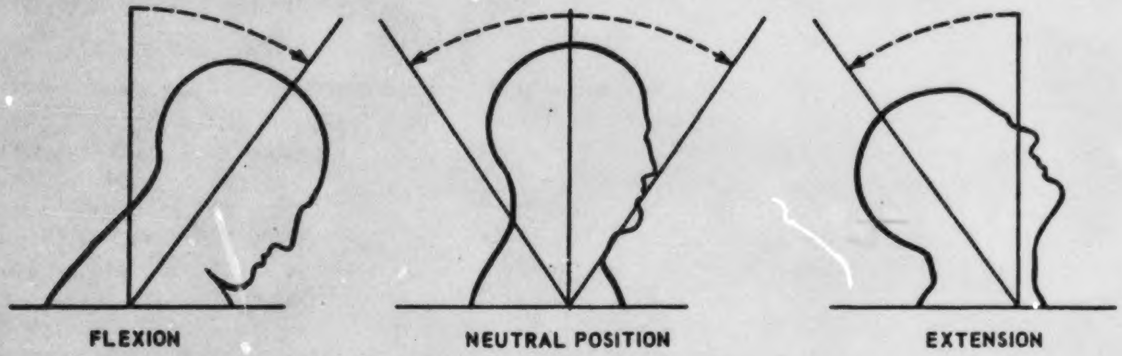
(2) *Coccyx.* The coccyx consists of multiple bony segments forming the distal tip of the spine.

c. Normal Relationship of the Vertebral Column to Some Flat Bones of Back. At the level of the third thoracic vertebra is the base of the spine of the scapula. At the level of the seventh thoracic vertebra is the inferior angle of the scapula. The crest of the ilium is at the level of the fourth lumbar vertebra, and the posterior iliac spine is at the level of the second sacral vertebra.

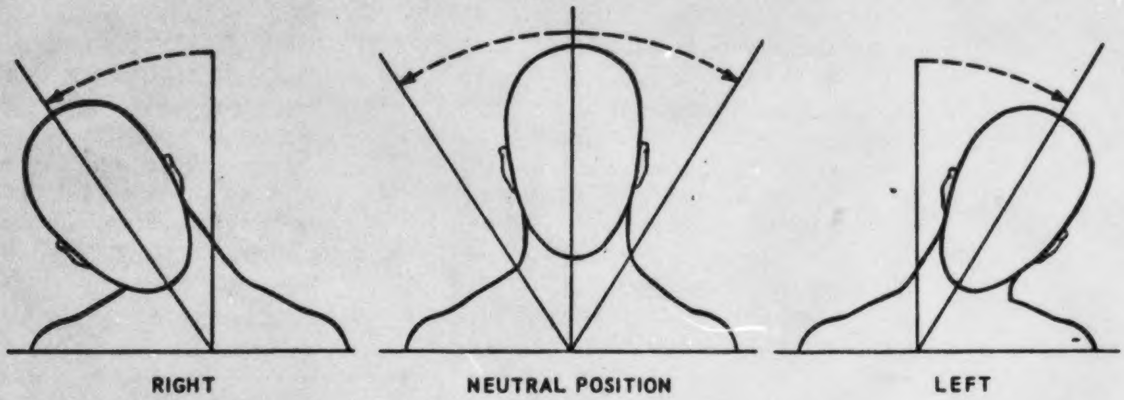
d. Movements of the Back. Movements of the back take place through the intervertebral joints. Movements of the head and neck are made possible in the cervical area of the vertebral column (fig. 8). In the thoracic area, movements are limited, allowing a minimum of interference with respiration. One of the reasons for the lack of motion in this area is the ribs themselves; it is not entirely due to the facing of the facets. Movements of the trunk occur chiefly in the lumbar area (fig. 9).

11. Thorax

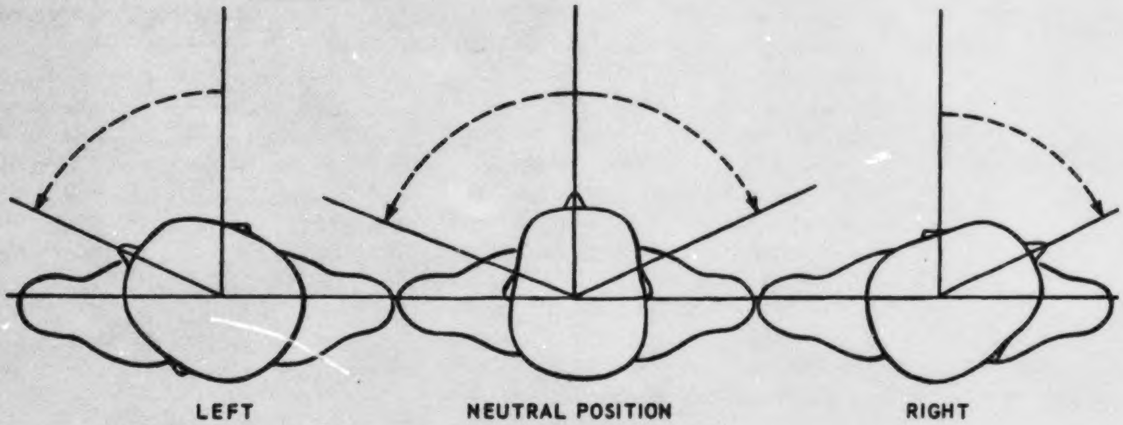
The thorax is a conical, elongated, bony cage formed by the sternum and costal cartilages in front, the 12 pairs of ribs (12 on each side),


FLEXION
NEUTRAL POSITION
EXTENSION

A. FLEXION AND EXTENSION
(OCCURS CHIEFLY IN THE LOWER CERVICAL AREA.)

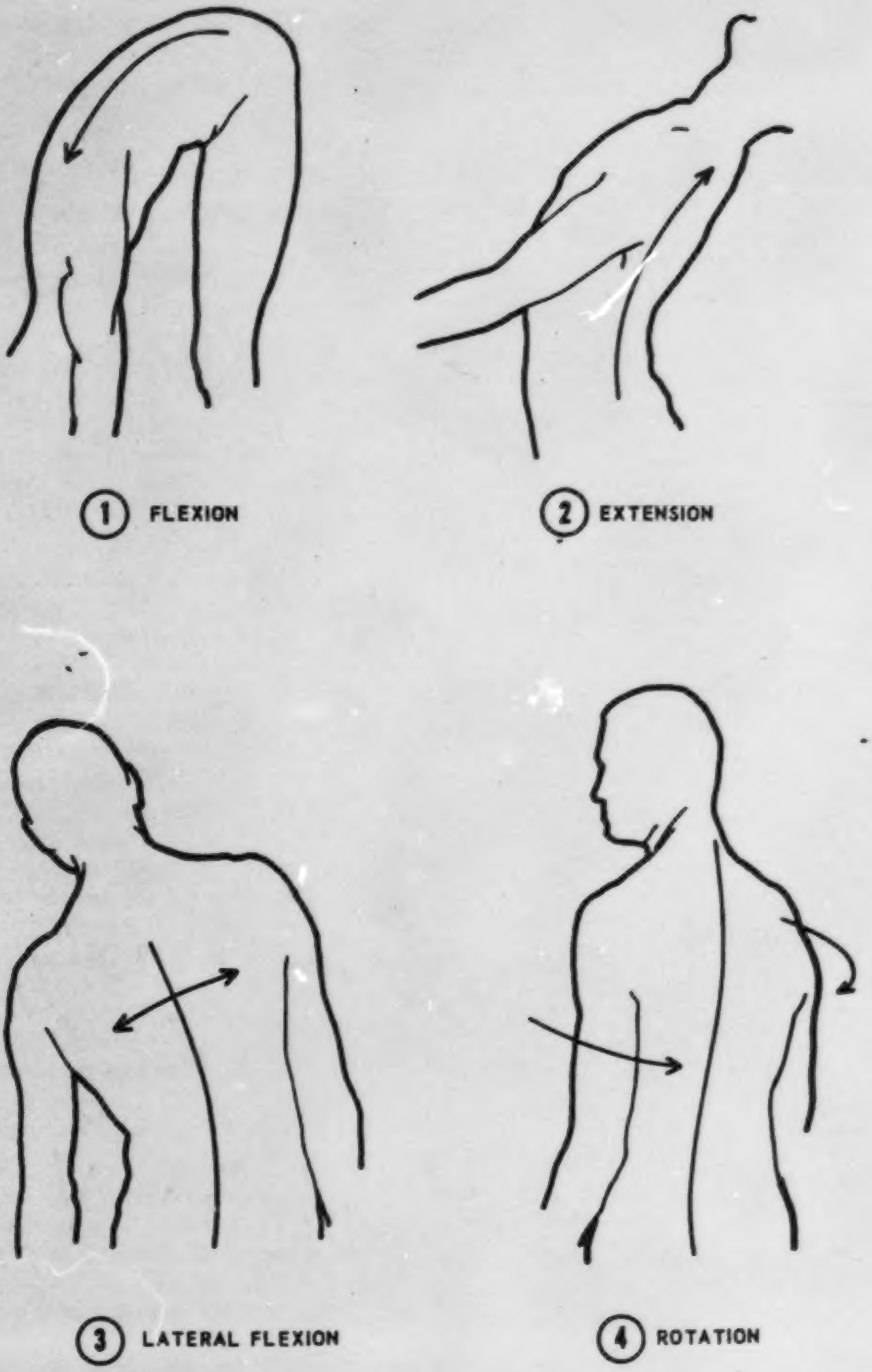

RIGHT
NEUTRAL POSITION
LEFT

B. LATERAL FLEXION
(OCCURS IN THE MIDCERVICAL AREA.)


LEFT
NEUTRAL POSITION
RIGHT

C. ROTATION
(OCCURS BETWEEN THE FIRST AND SECOND CERVICAL VERTEBRAE.)
HEAD TURNS TO RIGHT OR LEFT ACCOMPANIED BY SMALL AMOUNT OF LATERAL FLEXION TO SAME SIDE.

Figure 8. Head and neck motion.



① FLEXION

② EXTENSION

③ LATERAL FLEXION

④ ROTATION

Figure 9. Trunk motion.

and the bodies of the 12 thoracic vertebrae behind (fig. 10). It contains and protects the principal organs of circulation and respiration.

a. The sternum occupies the middle of the upper part of the chest wall in front. It is divided into an upper part, the manubrium; a small lower part, the xyphoid process; and between them, a body. It articulates above with the clavicles (collarbones) and on each side with the cartilages of the first seven ribs.

b. The ribs form a series of curved bony bands that support the chest wall. Behind, they articulate with the thoracic vertebrae. In front, each rib is provided with a costal cartilage. The first seven pairs of ribs articulate with the sternum by means of the cartilages and are called true ribs. The lower five pairs of ribs are not so supported and are called false ribs. The eighth, ninth, and tenth are united by their cartilages to the cartilages of the seventh. The last two pairs are free at their anterior ends and are called floating ribs.

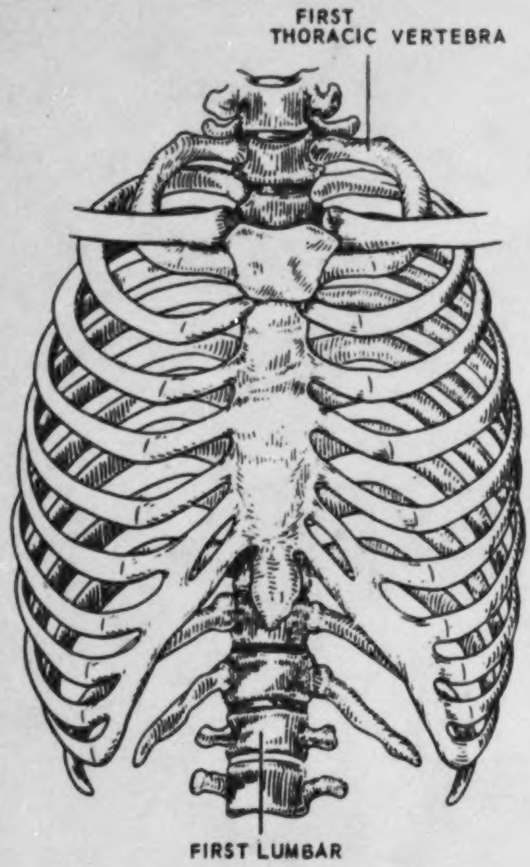


Figure 10. The thorax.

12. Shoulder Girdle
(figs. 11 and 12)

The shoulder girdle consists of two clavicles, two scapulae, and the manubrium (upper end of the sternum). The shoulder girdle is the structure by which the arm is attached to the body. Anteriorly, it is closed by the sternoclavicular joint. Posteriorly, there is no such joint to close it, and if it were not for the superficial muscles of the back stabilizing it to the chest it could not function with mobility.

a. Clavicle. The clavicle is a long S-shaped bone which runs horizontally along the upper chest above the first rib. It serves as a prop to support the shoulder and to hold it away from the chest wall.

(1) The clavicle is anchored medially at the *sternoclavicular joint.* This joint permits motion in all directions. Laterally, the clavicle articulates with the acromion process of the scapula. This articulation is called the *acromioclavicular joint.* The only movements permitted by this joint are rotation and the gliding motion.

(2) Behind the midsection of the clavicle and between the clavicle and the first and second ribs, pass the brachial plexus and the brachial vessels. The brachial plexus supplies the nerves to the structures of the upper limb (para 28*b*(2)).

b. Scapula. The scapula is a large roughly triangular bone which lies against the back of the thorax. The scapula's main function is to provide the attachment for the muscles which move the arm and shoulder and to articulate with the humerus, or the bone of the upper arm.

(1) Its anterior surface is concave so as to fit the posterior chest wall. Its body

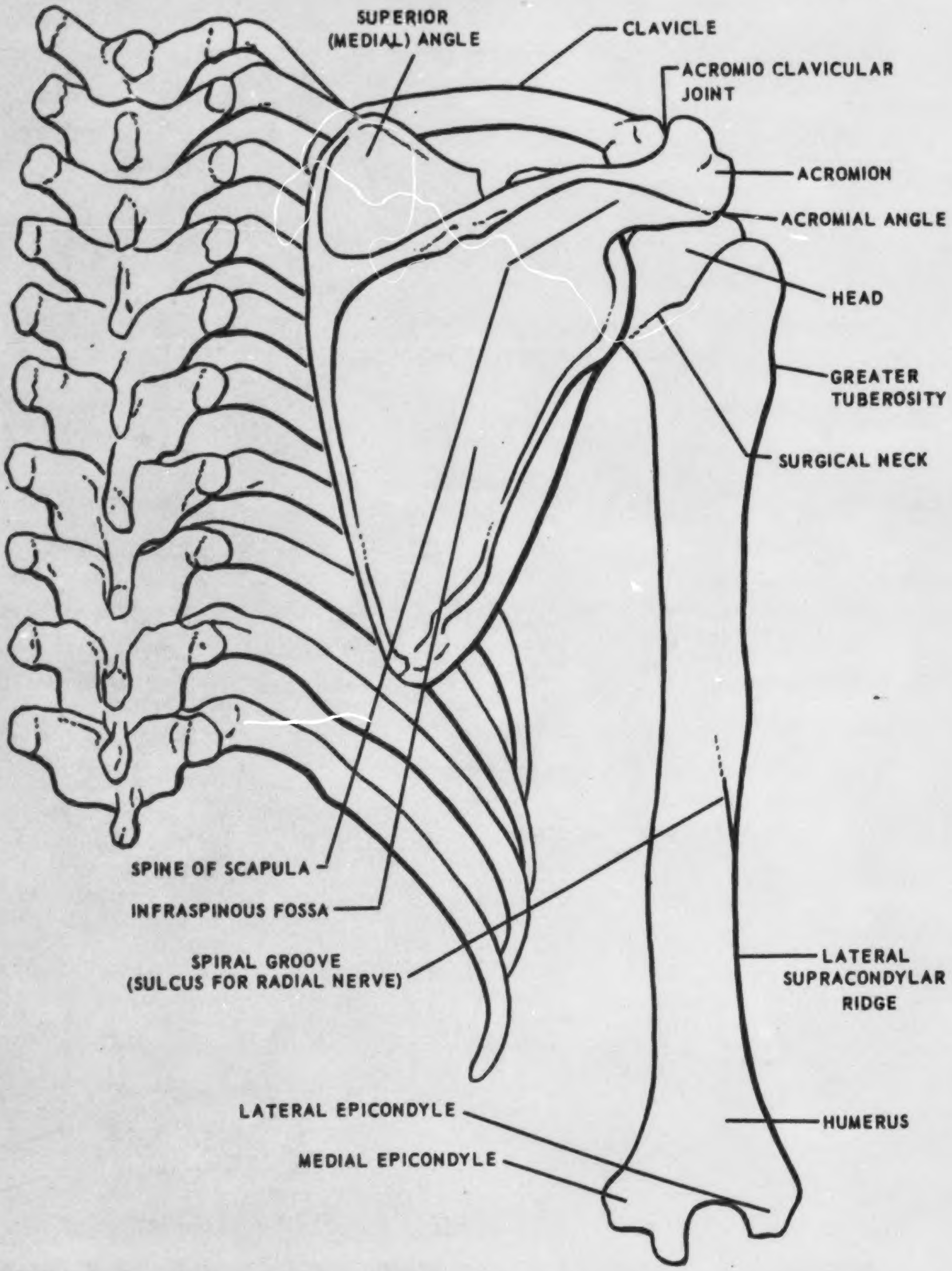
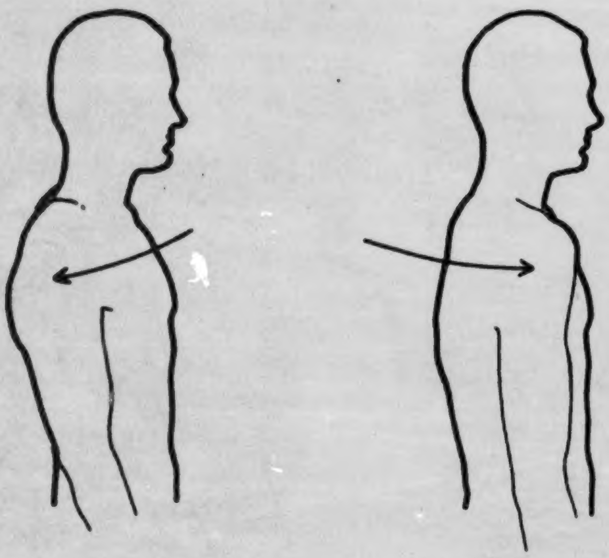

SUPERIOR (MEDIAL) ANGLE
CLAVICLE
ACROMIO CLAVICULAR JOINT
ACROMION
ACROMIAL ANGLE
HEAD
GREATER TUBEROSITY
SURGICAL NECK
SPINE OF SCAPULA
INFRASPINOUS FOSSA
SPIRAL GROOVE (SULCUS FOR RADIAL NERVE)
LATERAL SUPRACONDYLAR RIDGE
LATERAL EPICONDYLE
HUMERUS
MEDIAL EPICONDYLE

Figure 11. Shoulder girdle.

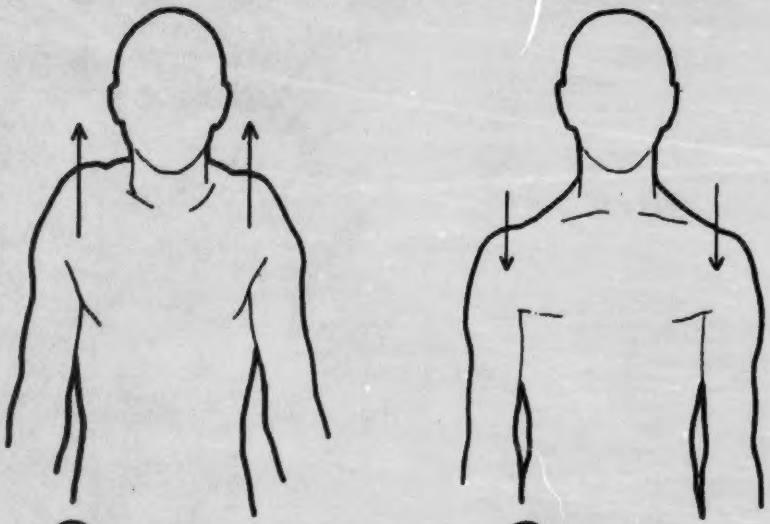


① ADDUCTION

(SCAPULAE MOVE TOWARD VERTEBRAL COLUMN.)

② ABDUCTION

(SCAPULAE MOVE AWAY FROM VERTEBRAL COLUMN.)



③ ELEVATION

(SCAPULAE AND CLAVICLES MOVE UPWARD.)

④ DEPRESSION

(SCAPULAE AND CLAVICLES MOVE DOWNWARD.)

Figure 12. Shoulder girdle motion.

is frequently paper thin. Muscles are attached above and below the spine of the scapula and on the anterior surface. The upper and lateral borders become thickened to form the neck, which is capped by the glenoid fossa (glenoid cavity). The glenoid fossa articulates with the head of the humerus to form the *shoulder joint.*

(2) The posterior surface of the scapula is convex, and its convexity is interrupted at the junction of the upper and middle thirds by a ridge of bone which is called the spine of the scapula. This spine can be readily palpated. It projects upward and laterally and ends in the blunt, heavy section of the bone called the acromion process.

(3) The acromion process, which projects beyond the scapula, protects the shoulder joint and articulates with the outer end of the clavicle. The clavicle is anchored to the coracoid process of the scapula by the coracoclavicular ligament.

(4) The coracoid process is a thick, curved, beaklike process attached by a broad base to the upper part of the neck of the scapula. It runs at first upward and medially and then projects forward and laterally.

13. Shoulder Joint

a. The shoulder joint is a ball and socket joint. It is composed of the large proximal end of the humerus, articulating with the relatively small, shallow glenoid fossa of the scapula (fig. 11). The depth of the genoid fossa is increased by a rim of fibrocartilage, the glenoidal labrum. Anterior stability of the shoulder joint is largely contributed by the anterior widening of the subscapularis tendon as it crosses the joint and inserts on the humerus.

b. The shallowness of the glenoid fossa, the relatively large head of the humerus, and the laxity with which the shoulder girdle is anchored to the chest contribute to the marked mobility of the shoulder joint and its proneness to dislocate. The shoulder joint has a greater range of motion than does any other joint in the body and is capable of every type of motion —flexion, extension, abduction, adduction, circumduction, and rotation (fig. 13).

c. The shoulder functions through a combination of arm and scapula motion. The arm can be brought out to an angle of 90 degrees by the supraspinatus and deltoid muscles, but in order to elevate the arm above the head the scapula must rotate. The supraspinatus arises from the dorsum of the scapula. It crosses under the acromion process and inserts on the greater tuberosity. If the supraspinatus tendon is torn or cut, abduction of the arm is impaired.

14. Humerus

The humerus, the long bone of the upper arm, consists of a head, an anatomical neck, a surgical neck, a shaft, and a distal extremity (fig. 11). The head of the humerus articulates with the glenoid fossa of the scapula to form the *shoulder joint.* The distal extremity of the humerus has two prominences, the medial (nearer the midline) and the lateral (farther from the midline) epicondyles, below which are the medial and lateral condyles. The medial and lateral condyles articulate with the ulna and the radius, respectively, to form the *elbow joint.*

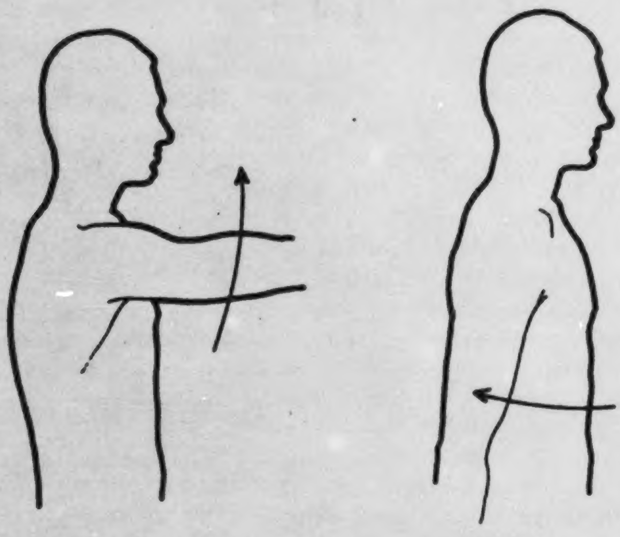
15. Forearm

(fig. 14)

The long bones of the forearm are the ulna and the radius.

a. The *ulna* is on the medial (little finger side) of the forearm. It is a long bone, larger at its upper end where it terminates as the prominent olecranon process to form the point of the elbow. It articulates above with the humerus and the radius and below with the radius. It has a prominence at the lower end called a styloid process, which can be felt beneath the skin at the wrist.

b. The *radius* is on the lateral (thumb side) of the forearm. It is a long bone much larger at the lower end than at the upper end. At the lower end is a styloid process, which can be felt beneath the skin. The radius articulates

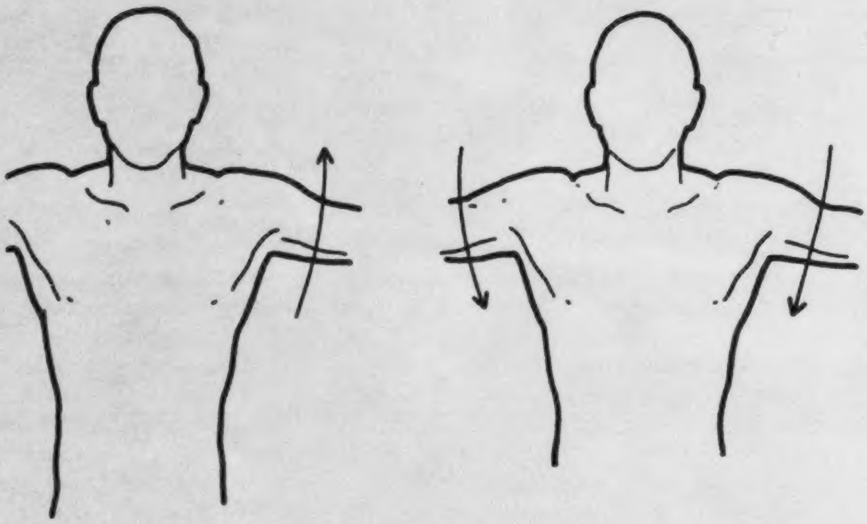


①FLEXION

ARM MOVES FORWARD

②EXTENSION

ARM MOVES BACKWARD



③ABDUCTION

ARM MOVES AWAY FROM TRUNK, LATERALLY

④ADDUCTION

ARM MOVES FROM ABDUCTION TOWARD TRUNK

Figure 13. Shoulder motion.

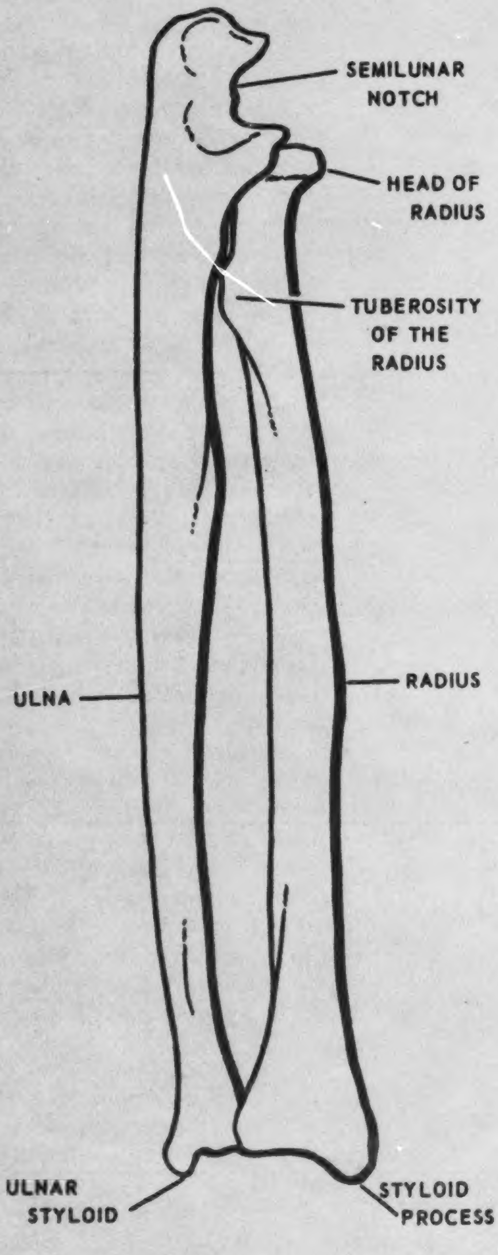


Figure 14. The forearm.

above with the humerus and the ulna and below with the carpal bones of the wrist and with the ulna. The radius enters into the formation of the elbow joint and forms a major part of the wrist joint.

16. Elbow Joint and Radio-Ulnar Joints

a. The *elbow joint,* the main part of which is the articulation of the humerus with the ulna, is a hinge joint. It has two strong ligaments on each side and powerful muscles anteriorly and posteriorly. It permits flexion and extension (fig. 15).

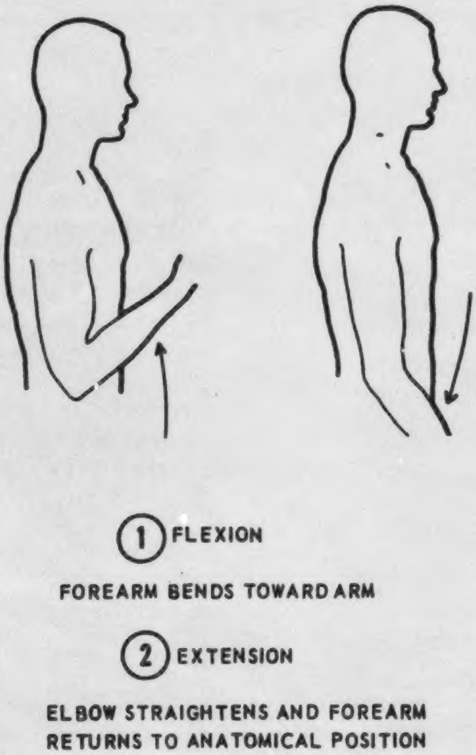
b. Both the upper and lower articulations of the radius and the ulna, or the *radio-ulnar joints,* are pivot joints and permit pronation and supination (fig. 16).

17. Wrist and Hand

(figs. 17 and 18)

a. Wrist.

(1) The carpus, or wrist, is made up of eight small, many-sided carpal bones, arranged in rows. The proximal row



① FLEXION

FOREARM BENDS TOWARD ARM

② EXTENSION

ELBOW STRAIGHTENS AND FOREARM RETURNS TO ANATOMICAL POSITION

Figure 15. Elbow motion.

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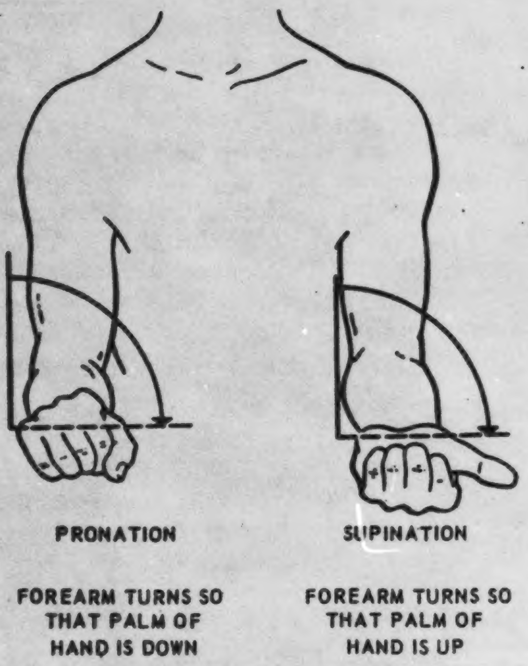
PRONATION
SUPINATION
FOREARM TURNS SO THAT PALM OF HAND IS DOWN
FOREARM TURNS SO THAT PALM OF HAND IS UP

Figure 18. Radio-ulnar motion.

(nearest the elbow), beginning from the radial side of the wrist, contains the *navicular*, *lunate*, *triangular*, and *pisiform* bones. The distal row (nearest the fingertips), beginning from the radial side of the wrist contains the *greater multangular*, *lesser triangular*, *capitate*, and *hamate* bones.

(2) The *radiocarpal joint*, or the wrist joint, provides articulation between the radius of the forearm and some of the carpal bones of the wrist. The wrist joint is a condyloid joint, strengthened in front and back and on both sides by ligaments. For movements of the wrist joint, see figure 19.

b. *Hand.* The hand is made up of 5 metacarpal bones and 14 phalanges.

(1) The metacarpal bones are located in the palm of the hand. They are numbered from one to five beginning at the thumb side. The proximal end of each metacarpal is called the base and articulates with the carpus, or wrist. The shaft of each metacarpal extends distally through the palm and terminates as an enlarged head. This head articulates with the proximal phalanx of the corresponding digit or finger.

(2) There are three phalanges in each finger and two in the thumb. The phalanx next to the palm is called the proximal phalanx; the one at the end of the digit, the distal phalanx; and the one between, the middle phalanx. The thumb has only a proximal phalanx and a distal phalanx.

(3) Between the two rows of carpal bones lie the *intercarpal joints*. The *carpometacarpal joints* are between the distal row of carpal bones and the metacarpal bones in the hand. Between the metacarpals and the proximal phalanges are the *metacarpophalangeal joints*, which are condyloid joints. Abduction and adduction are limited in these joints and cannot be performed when the fingers are flexed. The joints between the phalanges are called *interphalangeal joints*. The fingers have two, and the thumb, one. These joints are hinge joints which permit a considerable amount of flexion, especially between the proximal and middle phalanges. Extension is limited by the placement of the ligaments of the joints (fig.20).

18. Pelvic Girdle

The pelvic girdle is the boundary of the pelvis. It is a broad, strong ring of bone which supports the vertebral column and transmits to the lower limbs the weight of the rest of the body. It provides the attachment for the muscles which move the limbs and trunk and serves as a protective agent for the viscera of the pelvis.

a. The pelvic girdle is composed of two broad, flat bones (innominate), the sacrum, the coccyx, and strong ligaments. Each innominate bone is composed of three separate bones which fuse

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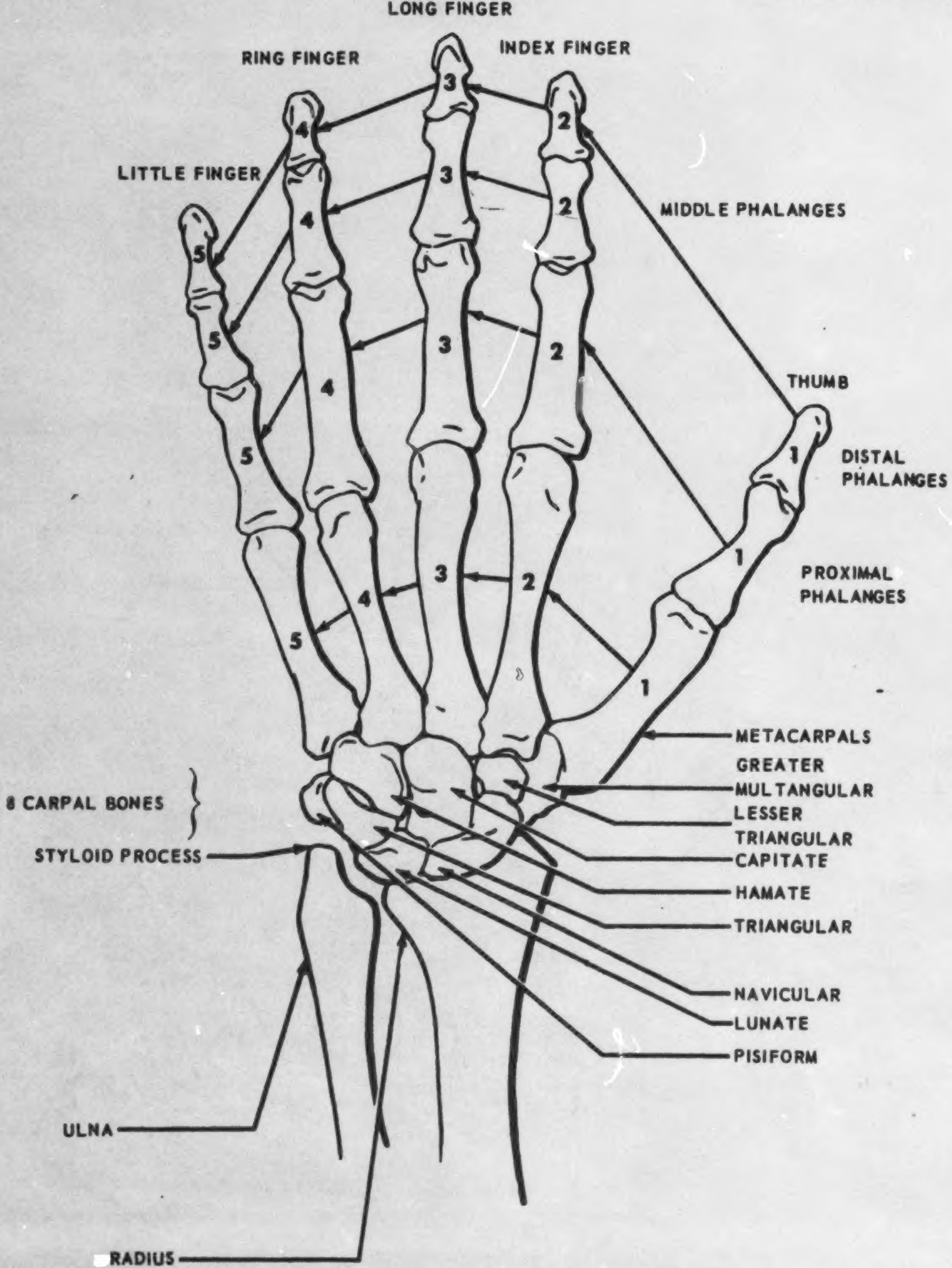
LONG FINGER
RING FINGER
INDEX FINGER
LITTLE FINGER
MIDDLE PHALANGES
THUMB
DISTAL PHALANGES
PROXIMAL PHALANGES
METACARPALS
GREATER MULTANGULAR
LESSER TRIANGULAR
CAPITATE
HAMATE
TRIANGULAR
NAVICULAR
LUNATE
PISIFORM
8 CARPAL BONES
STYLOID PROCESS
ULNA
RADIUS
1
2
3
4
5

Figure 17. Bones of the hand and wrist.

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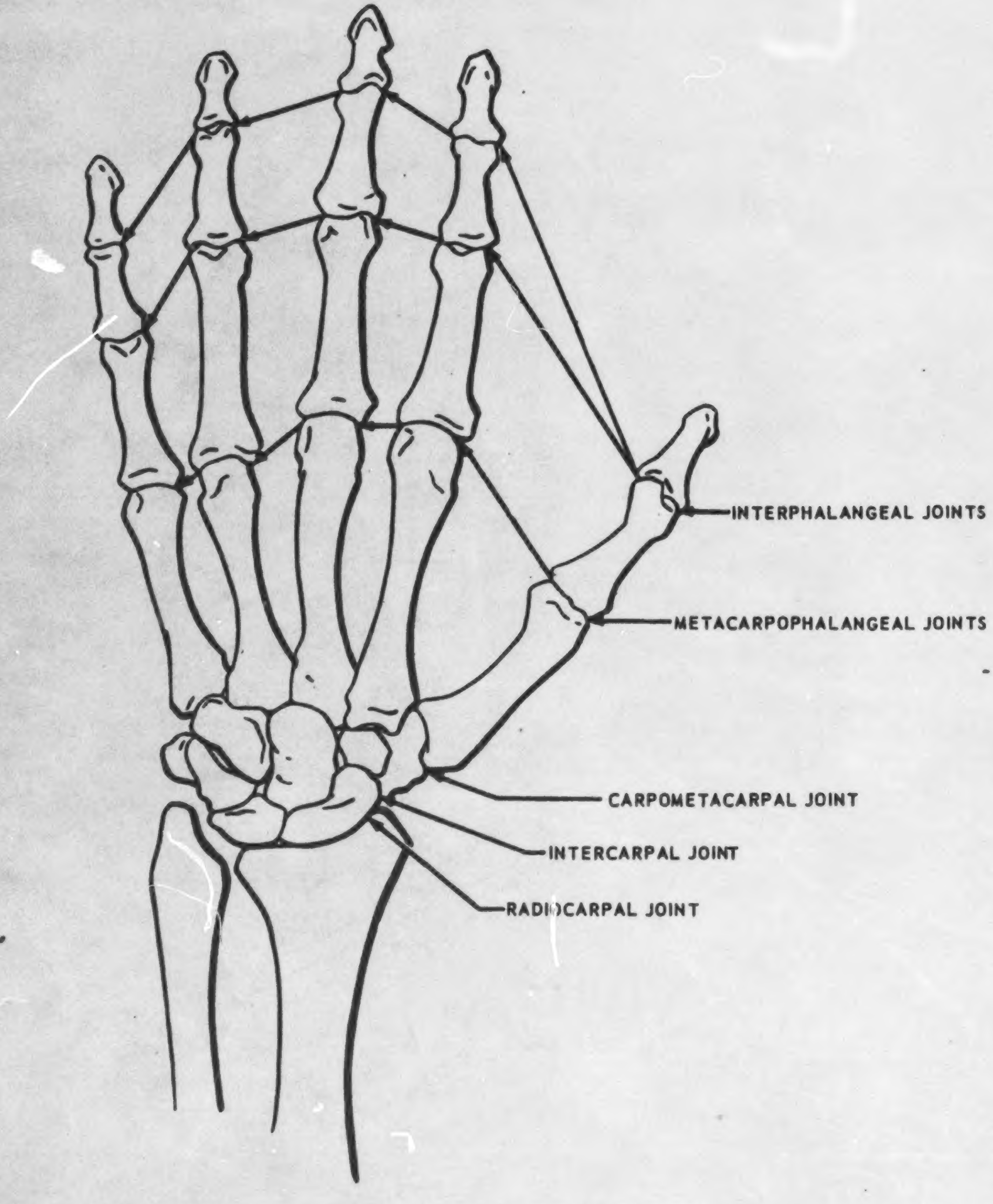
INTERPHALANGEAL JOINTS
METACARPOPHALANGEAL JOINTS
CARPOMETACARPAL JOINT
INTERCARPAL JOINT
RADIOCARPAL JOINT

Figure 18. Joints of the hand and wrist.

early in life. The ilium forms the superior and posterior part; the pubis, the anterior part; and the ischium, the inferior part. All three enter into the formation of the acetabulum

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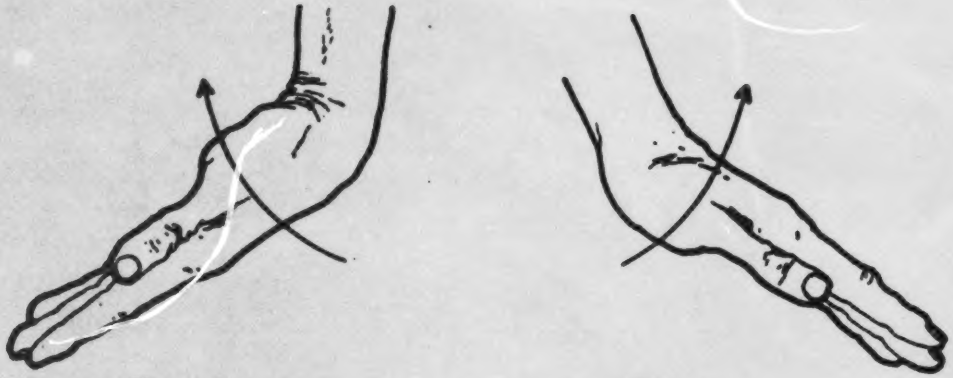
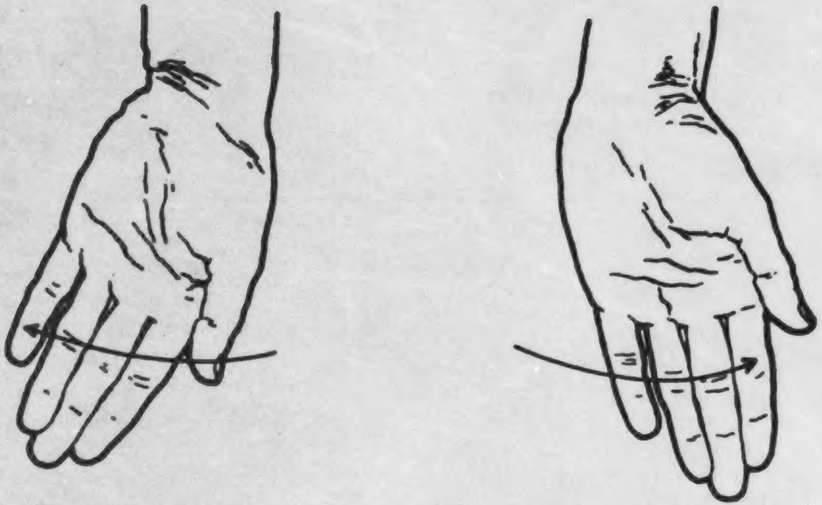


① **FLEXION**

HAND MOVES FORWARD.

② **EXTENSION**

HAND MOVES BACKWARD.



③ **ULNAR DEVIATION**

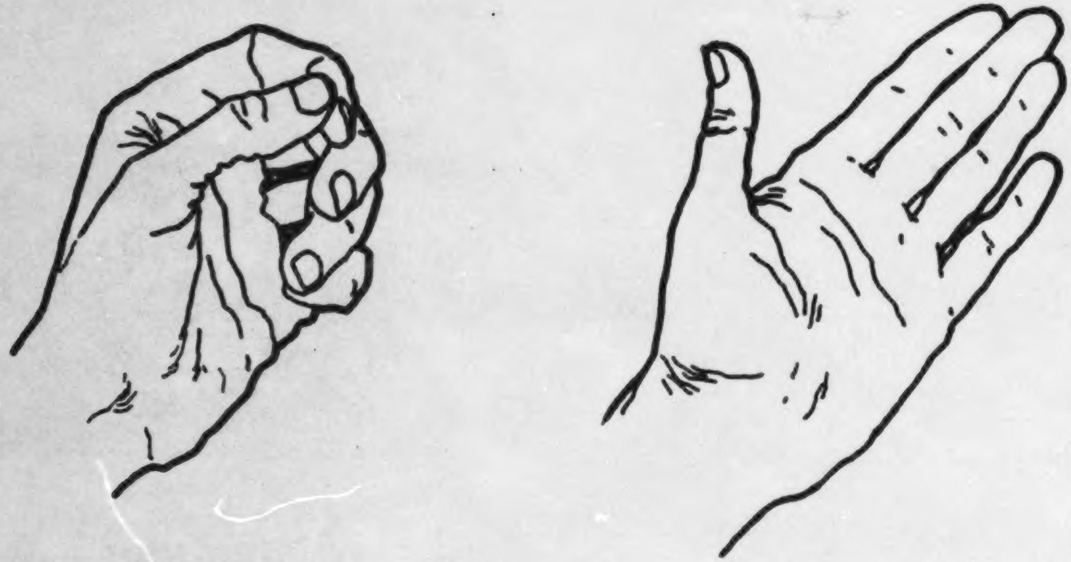
(ADDUCTION)
HAND MOVES TOWARD LITTLE
FINGER SIDE.

④ **RADIAL DEVIATION**

(ABDUCTION)
HAND MOVES TOWARD THUMB SIDE.

CIRCUMDUCTION
(A CIRCULAR MOVEMENT – A COMBINATION OF THE ABOVE.)

Figure 19. Wrist motion.



① FLEXION

FINGERS BEND FORWARD AT METACARPOPHALANGEAL JOINTS AND AT INTERPHALANGEAL JOINTS

② EXTENSION

FINGERS RETURN TO STRAIGHTENED POSITION

Figure 20. Finger motion.

(socket of the *hip joint*). The sacrum, a large wedge-shaped bone, closes the ring behind and articulates with the innominate bones at the *sacroiliac joints* (fig. 21).

(1) Each ilium is composed of a body and a wing. The body enters into the formation of the acetabulum where it unites with the pubis in front and the ischium below. It forms part of the sciatic notch behind. Through this notch passes the sciatic nerve (para 28*b*(5)), so frequently referred to in back and leg pathology. The wings of the ilium form the sides of the pelvis, and their long, curved, superior borders are palpated throughout as the iliac crests. They terminate in front and behind as anterior and posterior superior iliac spines. The inner surface of the ilium is divided into a large iliac fossa and a small articular surface for the sacrum. Except for the articular surface, the internal and external surfaces are covered with muscles.

(2) Each pubic bone consists of a body and two rami. The two bodies unite to form an arch called the *symphysis pubis*, a rudimentary joint which is strongly reinforced by dense transverse ligaments. The superior ramus extends outward to enter into the formation of the acetabulum, whereas the inferior ramus passes downward to unite with the ascending ramus of the ischium.

(3) Each ischium consists of a body, which enters into the acetabulum, a tuberosity which faces downward and upon which we sit, and a ramus,

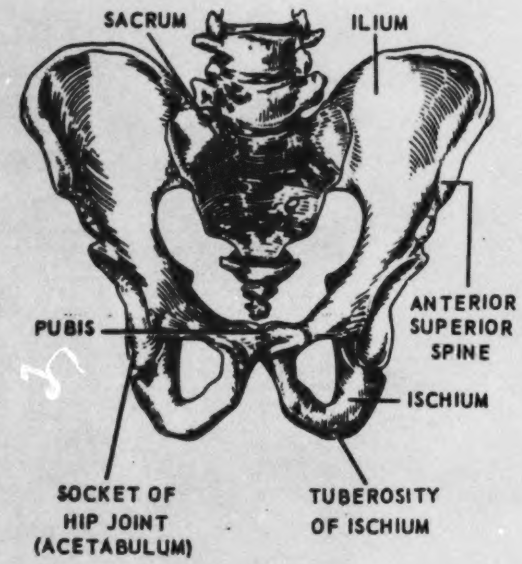


Figure 21. Bones of the pelvic girdle.

which unites with the descending ramus of the pubis. The *ischial tuberosity* is the weight-bearing part used in the weight-bearing brace and above-knee prosthesis.

b. Normally there is very little movement in the pelvis proper. During pregnancy, however, the pelvic joints and ligaments may become relaxed. The symphysis can be palpated anteriorly. The anterior superior spine can be readily identified. The outer lip of the crest of the ilium can be followed posteriorly to the posterior, superior iliac spine which lies at the level of the middle of the sacroiliac joint. The gluteal muscles mask the lateral flare of the ilium; however, the dorsal surface of the sacrum and its spinous processes, the ischial tuberosities, and the inferior ramus can be palpated.

19. Hip Joint

The hip joint is a ball and socket joint in which the head of the femur fits into the socket formed by the ilium, the pubis, and the ischium. The hip joint is surrounded by a very strong capsule and ligaments. The strongest ligaments in the body are those in front of the hip joint. Movements of the hip joint are illustrated in figure 22.

20. Femur

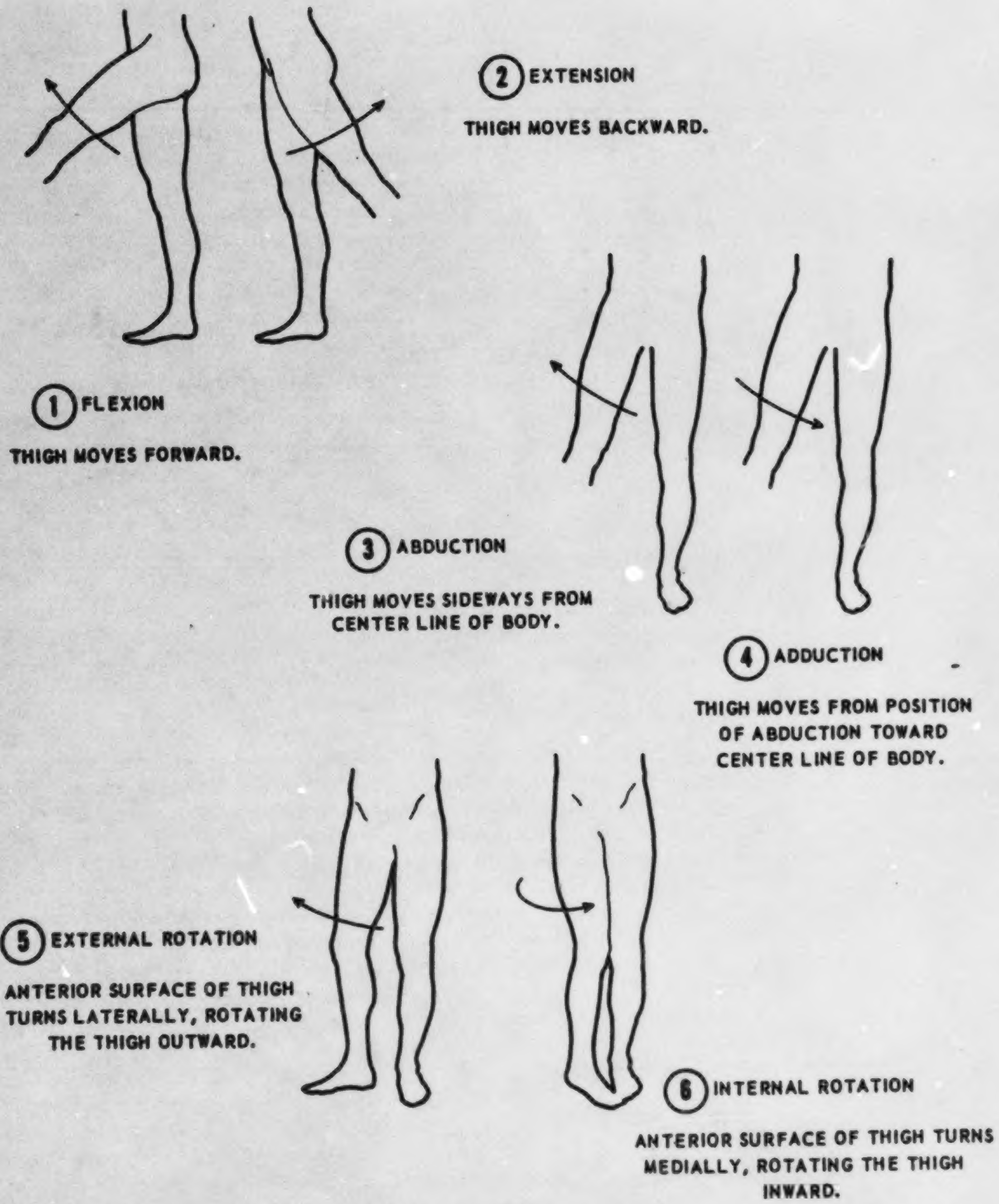
The femur, or the thigh bone, is the longest, heaviest, and strongest bone of the body. It transmits the entire weight of the trunk from the hip to the tibia. The proximal end is made up of a head and neck and two processes, the greater and lesser trochanters. The head fits into the acetabulum to form the *hip joint.* The distal end is made up of two condyles which articulate with the tibia and the patella (figs. 3 and 23).

21. Patella, Knee Joint, and Menisci

a. The *patella,* or kneecap, lies over the front of the knee joint and overlaps the distal end of the femur. It is in the tendon of the quadriceps muscle. This tendon may be displaced and the patella dislocated by a direct blow against the inner side of the patella when the knee is slightly flexed, or by a valgus (bent outward) strain which tears the medical capsule or collateral ligament.

b. The articulations of the femur with the tibia and the patella constitute the *knee joint* (fig. 24). The knee joint is a modified hinge joint, enveloped in a capsule and supported by strong ligaments and by the very strong tendon of the quadriceps muscle in which the patella is located. A great deal of leverage is imposed upon the knee by the long bones of the thigh and lower leg. For movements of the knee joint, see figure 25.

c. Between the femur and the tibia, at the periphery of the knee joint, are two *menisci* (crescent-shaped cartilages), a lateral meniscus beneath the lateral condyle of the femur and a medial one beneath the medial femoral condyle. The anterior and posterior extremities of the menisci are attached to the tibia, and the middle part of the medial meniscus is attached to a medial collateral ligament. The menisci glide with the tibia against the femur. Occasionally the menisci enter the knee joint and become pinched and lacerated beneath the weight-bearing femur and tibia. This can happen when the knee is twisted. A tear of the medial meniscus occurs more frequently than does a tear of the lateral meniscus.


① FLEXION
THIGH MOVES FORWARD.
② EXTENSION
THIGH MOVES BACKWARD.
③ ABDUCTION
THIGH MOVES SIDEWAYS FROM CENTER LINE OF BODY.
④ ADDUCTION
THIGH MOVES FROM POSITION OF ABDUCTION TOWARD CENTER LINE OF BODY.
⑤ EXTERNAL ROTATION
ANTERIOR SURFACE OF THIGH TURNS LATERALLY, ROTATING THE THIGH OUTWARD.
⑥ INTERNAL ROTATION
ANTERIOR SURFACE OF THIGH TURNS MEDIALLY, ROTATING THE THIGH INWARD.

(CIRCUMDUCTION, A CIRCULAR MOVEMENT, IS A COMBINATION OF FLEXION, EXTENSION, ABDUCTION, AND ADDUCTION.)

Figure 22. Hip motion.

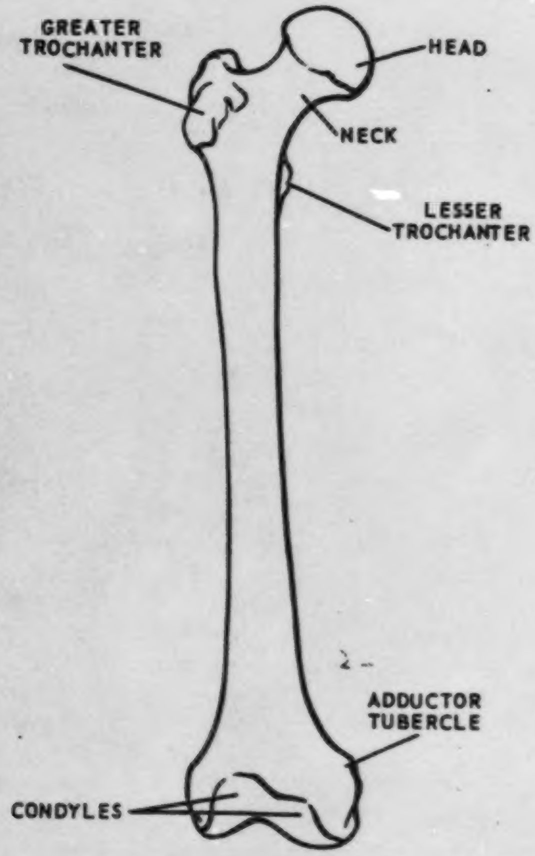


Figure 25. Anterior view of right femur.

22. Tibia and Fibula
(fig. 26)

The two long bones of the leg are the strong, weight-bearing tibia (shin bone) and the slender fibula (splint bone). The tibia is important in the construction of both the knee joint and the ankle joint.

a. The *tibia* lies on the medial side of the leg. The expanded proximal end consists of medial and lateral condyles, which articulate with the femur to form the knee joint. The outer lower side of the lateral condyle articulates with the fibula. Medially the distal end has a prominence called the medial malleolus, distally an articular surface for the talus (one of the bones of the foot), and laterally a smaller articular surface for the fibula. The medial malleolus of the tibia is important in the construction of the ankle joint. The tibia conveys to the foot the load transmitted by the femur.

b. The *fibula*, which is on the lateral or outer side of the leg, has two enlarged ends. The upper end articulates with the tibia alone. The lower end articulates with the tibia and also with the talus. The prominent part of the lower end of the bone is called the lateral malleolus, which can be felt beneath the skin. It assists in forming the ankle joint. The fibula provides a framework for muscle attachment and furnishes protection for important blood vessels.

23. Ankle and Foot
(fig. 27)

a. Tarsus. The tarsus, or the hind part of the foot, consists of seven tarsal bones. The *talus*, the second largest of these bones, articulates with the tibia and the fibula to form the ankle joint. The *calcaneus*, which forms the base of the heel, transmits the weight of the body to the ground. The other tarsal bones are the *navicular*, a boat-shaped bone; the first, second, and third *cuneiforms*; and the *cuboid* bone.

b. Metatarsus. The metatarsus, or the forefoot, is the part of the foot between the tarsus and the toes. It consists of five metatarsal bones and 14 phalanges. There are two phalanges in the great toe and three in each of the others. The metatarsal bones are similar to the metacarpal bones of the hand, but are slightly longer and heavier. The phalanges in the toes are similar in number, structure, and arrangement to those of the fingers, but they are shorter.

c. Arches. The foot is constructed in a series of arches, which assist in bearing the weight of the body. The seven tarsal and five metatarsal bones are bound together by ligaments to form the *longitudinal arch*. There is also a series of *transverse arches*, strengthened by ligaments and by the short muscles of the great toe and the fifth toe, which augment the weight-bearing qualities of the foot.

d. Joints (fig. 28).

(1) The *ankle joint* (articulation of talus

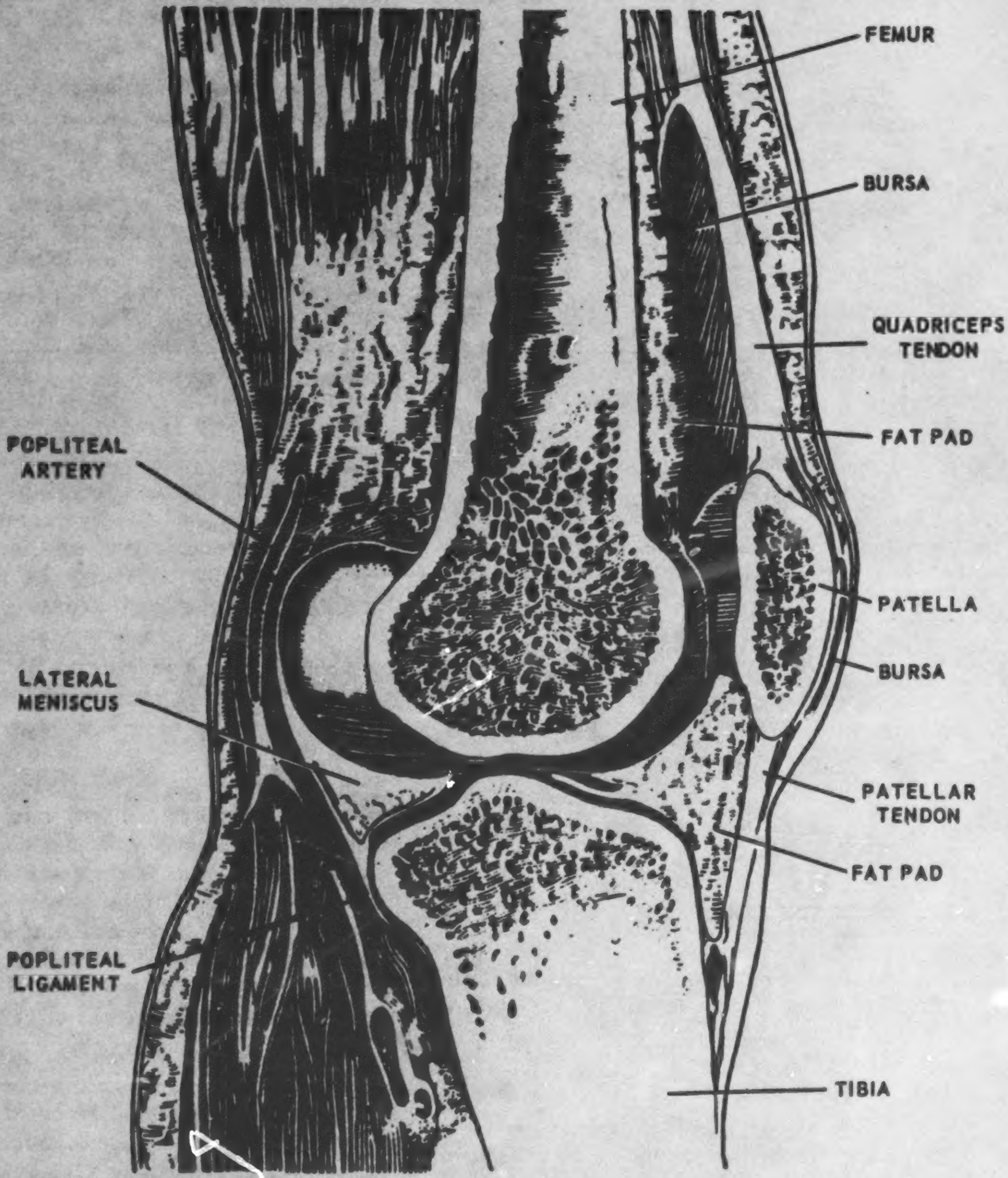

FEMUR
BURSA
QUADRICEPS TENDON
FAT PAD
POPLITEAL ARTERY
PATELLA
LATERAL MENISCUS
BURSA
PATELLAR TENDON
FAT PAD
POPLITEAL LIGAMENT
TIBIA

Figure 24. Knee joint, sagittal section.

with tibia and fibula) is a hinge joint surrounded by a capsule and supported by strong ligaments front and back. The ankle joint permits dorsiflexion and plantar flexion.

(2) The *subtalar joint* is the articulation

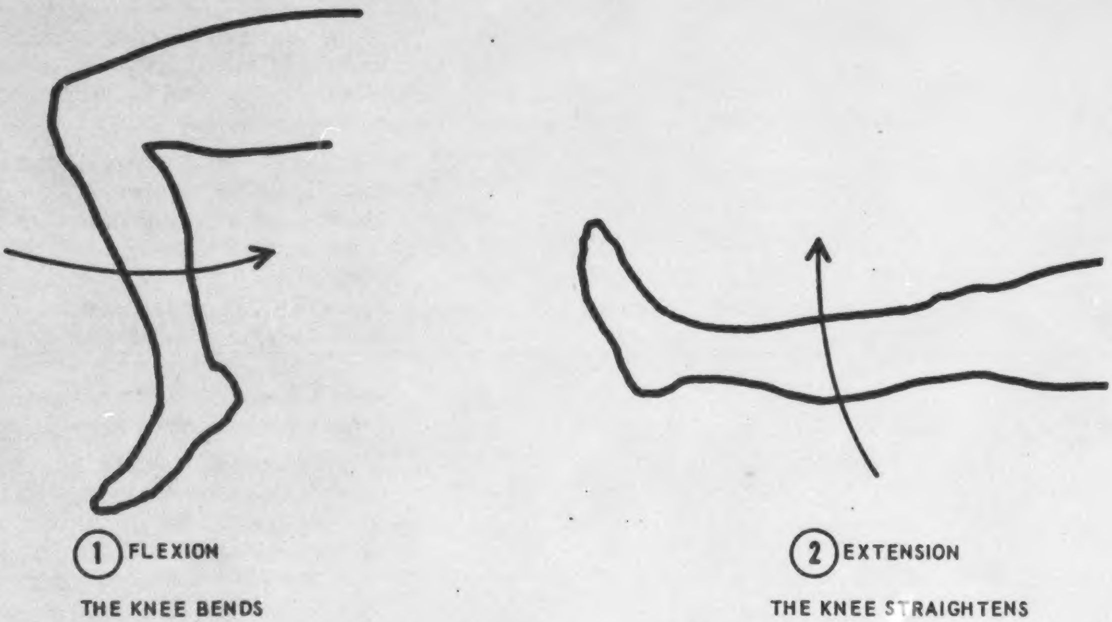


Figure 25. Knee motion.

of the talus with the calcaneus bone. It permits inversion and eversion.

(3) The *tarsal joints* (articulations of bones of tarsus) are strongly made gliding joints. The midtarsal joints permit inversion and eversion.

(4) The *metatarsophalangeal joints* (articulations of metatarsals and phalanges) are of the condyloid type. Movements permitted by these joints are flexion, extension, abduction, and adduction.

(5) The *interphalangeal joints* (articulations of phalanges) are hinge joints. There is one in the great toe and two in each of the other toes. More movement is permitted between the first and second phalanges than between the second and third. Movements permitted by these joints are flexion and extension.

Section II. NERVOUS SYSTEM

24. General

(figs. 29 through 33)

The nervous system is the regulator and coordinator of the various intellectual and physical processes of the individual. The parts of the nervous system may be considered under the following closely interrelated systems:

a. Central Nervous System. This system consists of the brain and the spinal cord, which are made up of nerve cells and their processes and fibers. It controls the voluntary muscles of the body and interprets sensory stimuli. The brain and the spinal cord communicate with other parts of the body by means of cranial and spinal nerves.

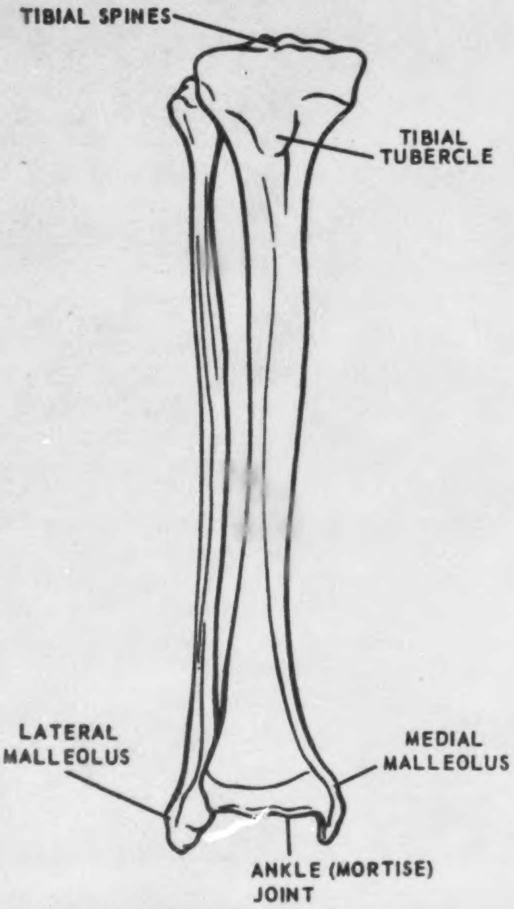


Figure 26. Anterior view of right tibia and fibula.

b. Peripheral Nervous System. This system includes the nerve fibers of 12 pairs of cranial nerves and 31 pairs of spinal nerves which stem from the brain and the spinal cord, respectively. The peripheral nervous system primarily involves conscious activity of the body. It carries impulses of sensation, such as touch, pain, or sight to the brain; the brain normally evaluates the message and sends out impulses which cause a bodily response.

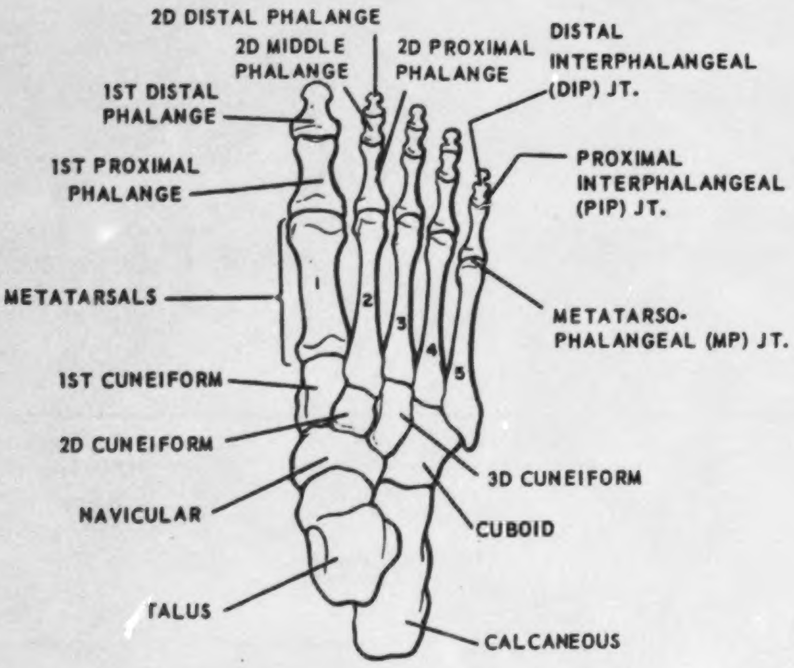
c. Autonomic Nervous System. The autonomic nervous system consists of nerve fibers and ganglia (accumulation of nerve cells). This system influences the activity of the cardiac and smooth muscle, sweat glands, digestive glands, some of the endocrine glands, and the dilation and contraction of blood vessels. Its control over these activities is almost involuntary. It is further divided into the *sympathetic nervous system* and the *parasympathetic nervous system.*

25. Neurons

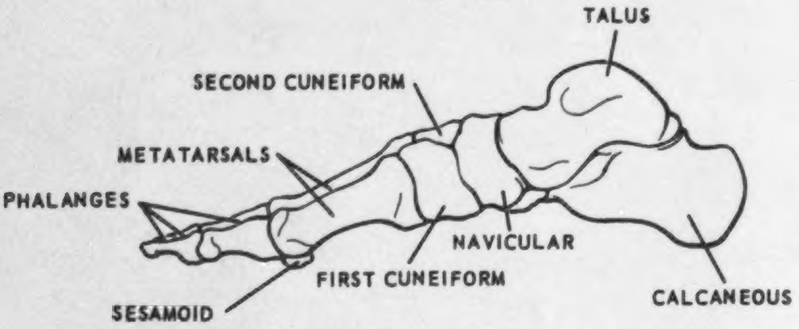
a. The basic unit of the entire nervous system is the specialized cell, or neuron. Neurons are cells which have marked powers of irritability and conductivity. They receive nerve impulses and transmit them to other cells. The passage of the nerve impulse usually involves two or more neurons, and the junction between neurons is known as the *synapse.* The exact nature of this connection between neurons is unknown. Neurons are classified according to their functions.

(1) *Sensory (or afferent) neurons* are those which transmit impulses *to* the central nervous system. At the distal end of the sensory neuron chain will be found a sensory receptor, such as the receptors of pain, touch, taste, and temperature.

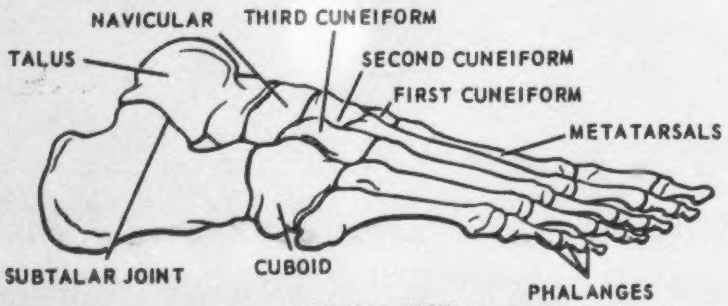
(2) *Motor (or efferent) neurons* are those which transmit impulses *from* the


2D DISTAL PHALANGE
2D MIDDLE PHALANGE
2D PROXIMAL PHALANGE
DISTAL INTERPHALANGEAL (DIP) JT.
1ST DISTAL PHALANGE
1ST PROXIMAL PHALANGE
PROXIMAL INTERPHALANGEAL (PIP) JT.
METATARSALS
1
2
3
4
5
METATARSO-PHALANGEAL (MP) JT.
1ST CUNEIFORM
2D CUNEIFORM
3D CUNEIFORM
NAVICULAR
CUBOID
TALUS
CALCANEOUS

TOP VIEW

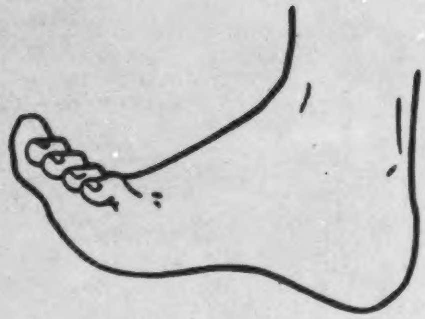

TALUS
SECOND CUNEIFORM
METATARSALS
PHALANGES
NAVICULAR
FIRST CUNEIFORM
CALCANEOUS
SESAMOID

MEDIAL VIEW

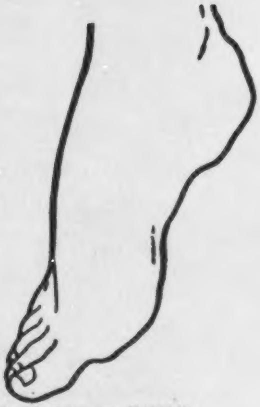

NAVICULAR
THIRD CUNEIFORM
TALUS
SECOND CUNEIFORM
FIRST CUNEIFORM
METATARSALS
SUBTALAR JOINT
CUBOID
PHALANGES

LATERAL VIEW

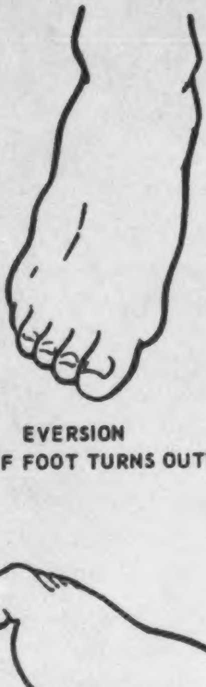
Figure 27. Bones and joints of the foot.



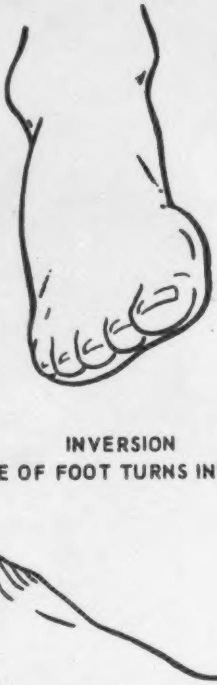
DORSIFLEXION
(FOOT MOVES UP)



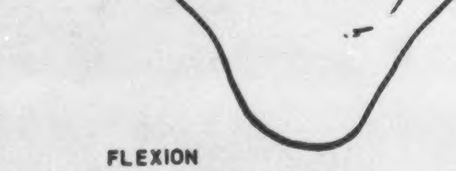
PLANTAR FLEXION
(FOOT MOVES DOWN)



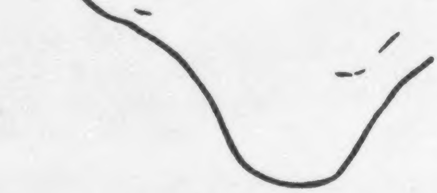
EVERSION
(SOLE OF FOOT TURNS OUTWARD)



INVERSION
(SOLE OF FOOT TURNS INWARD)



FLEXION
(TOES CURL TOWARD SOLE)



EXTENSION
(TOES STRAIGHTEN)

Figure 28. Ankle, foot, and toe motion.

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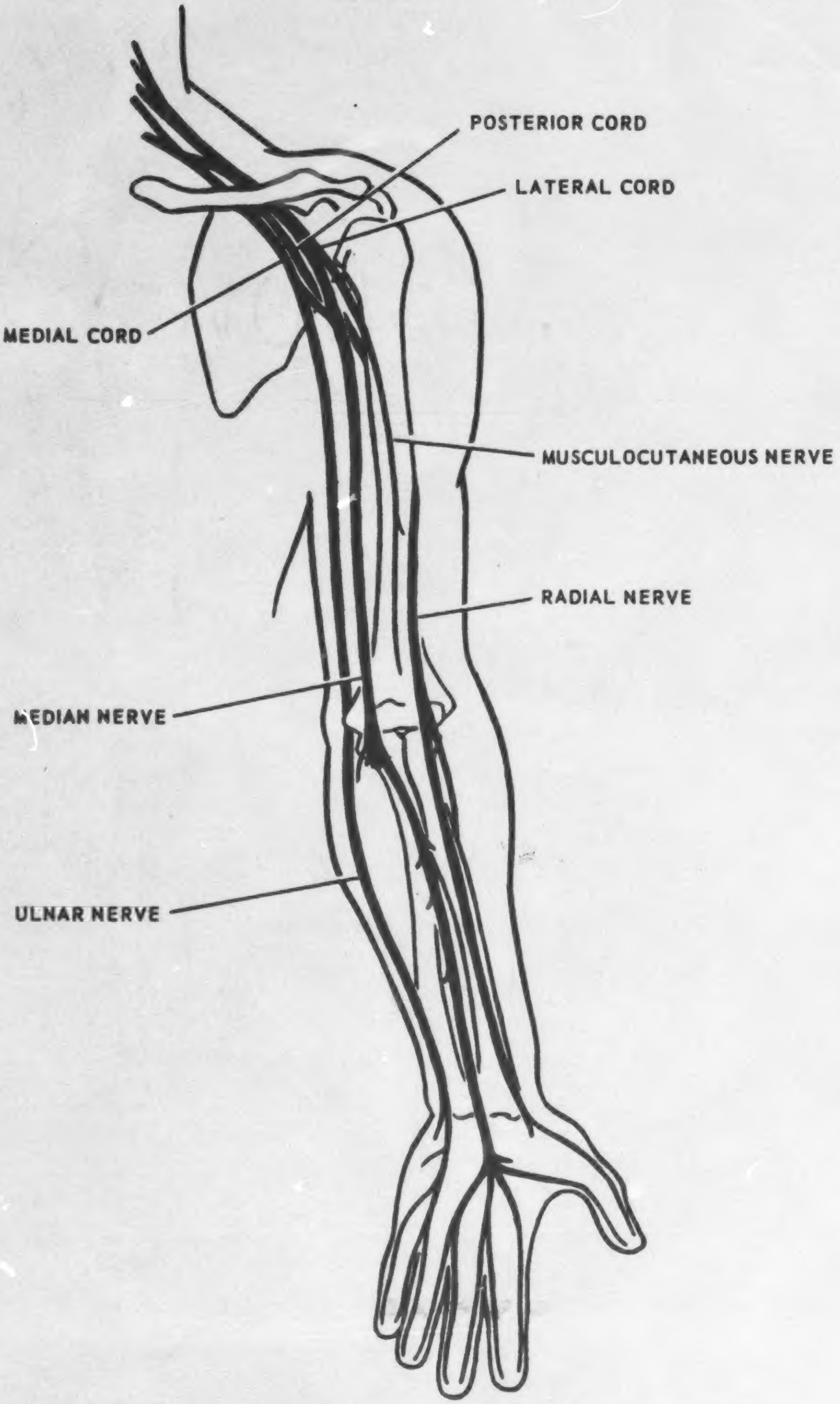
POSTERIOR CORD
LATERAL CORD
MEDIAL CORD
MUSCULOCUTANEOUS NERVE
RADIAL NERVE
MEDIAN NERVE
ULNAR NERVE

Figure 29. Schematic diagram of the nervous system, upper limb.

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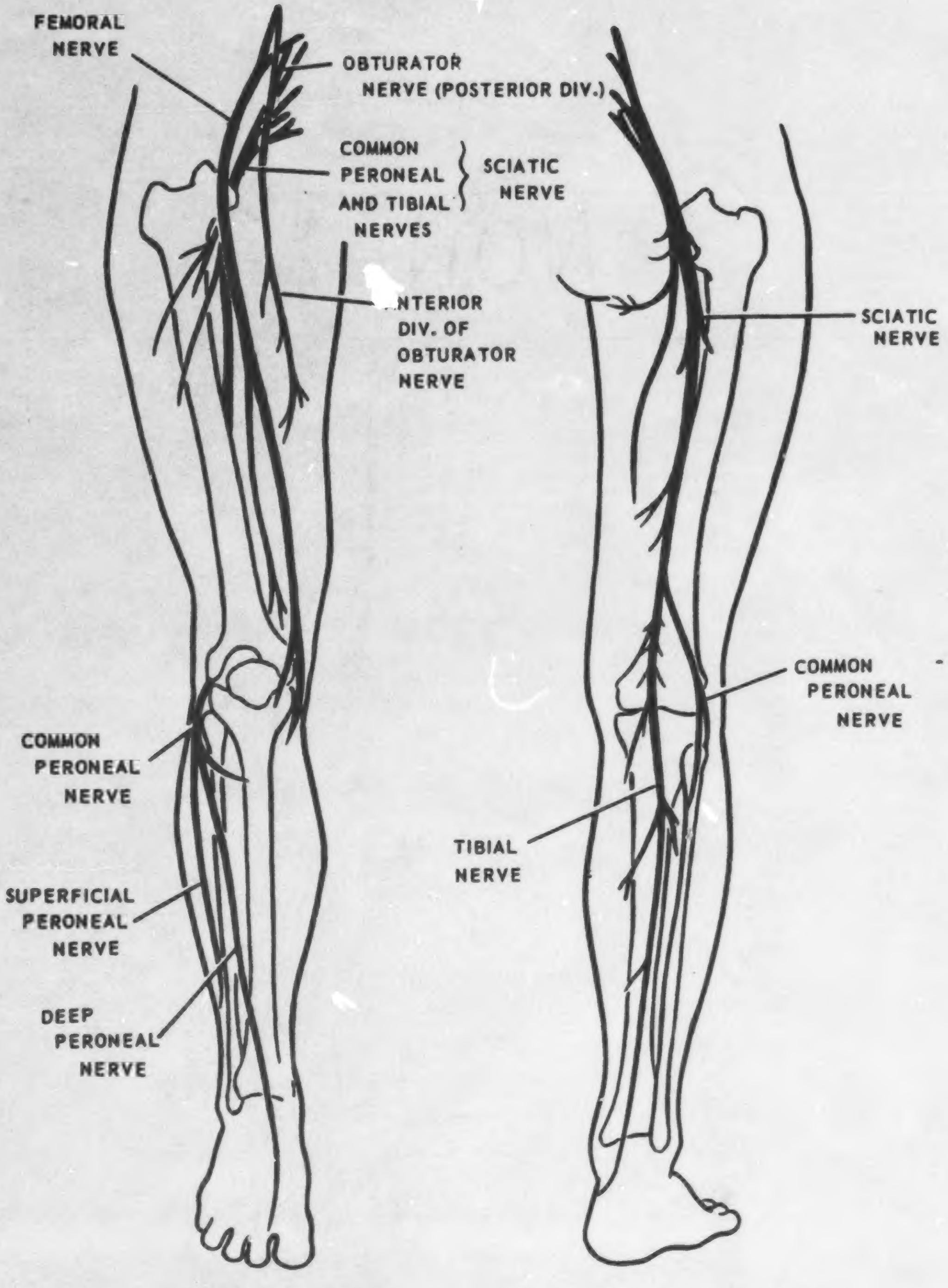
FEMORAL NERVE
OBTURATOR NERVE (POSTERIOR DIV.)
COMMON PERONEAL AND TIBIAL NERVES
SCIATIC NERVE
ANTERIOR DIV. OF OBTURATOR NERVE
SCIATIC NERVE
COMMON PERONEAL NERVE
COMMON PERONEAL NERVE
TIBIAL NERVE
SUPERFICIAL PERONEAL NERVE
DEEP PERONEAL NERVE

Figure 30. Schematic diagram of the nervous system, lower limb.

2 48

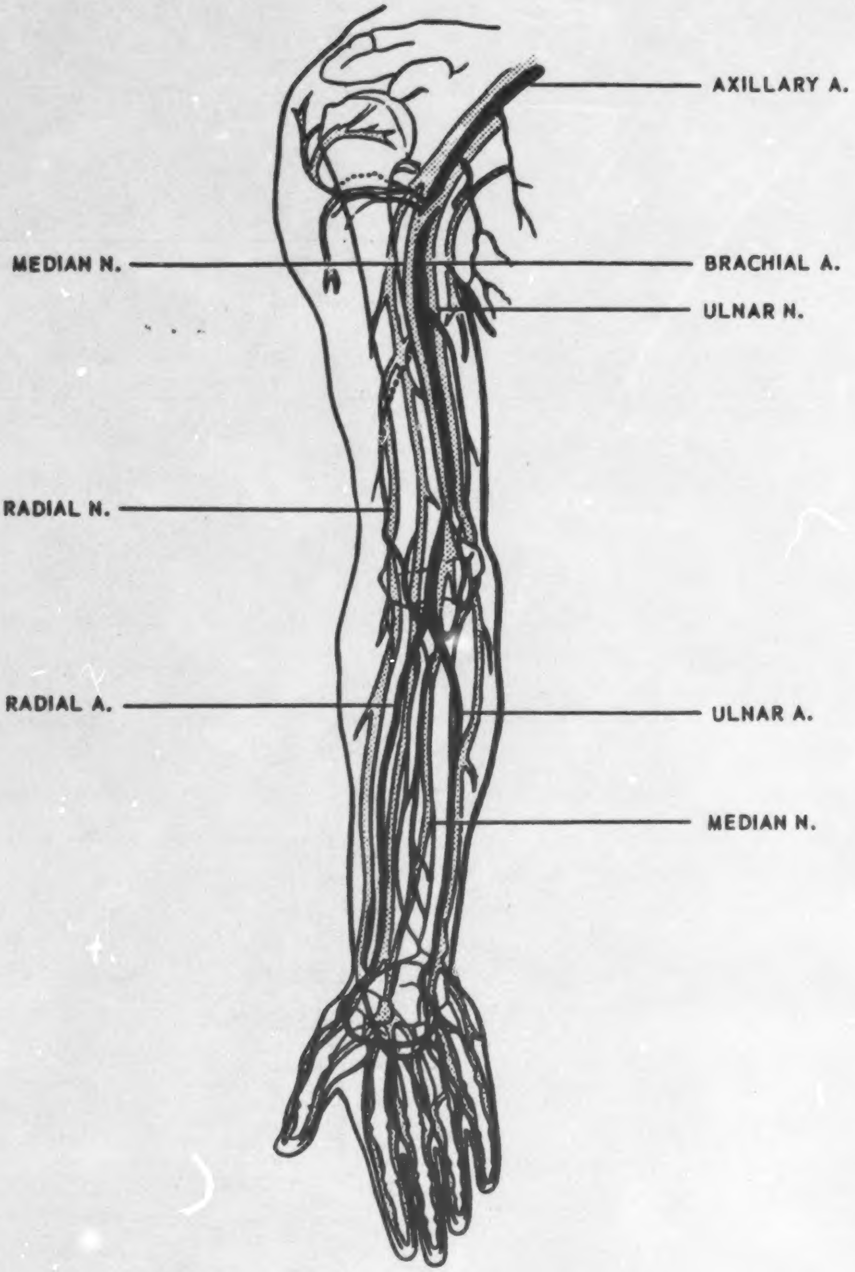
AXILLARY A.
MEDIAN N.
BRACHIAL A.
ULNAR N.
RADIAL N.
RADIAL A.
ULNAR A.
MEDIAN N.

Figure 31. Nerves and blood vessels (major) of the upper and lower limbs indicating bony relationships.
Right upper limb, viewed from in front.

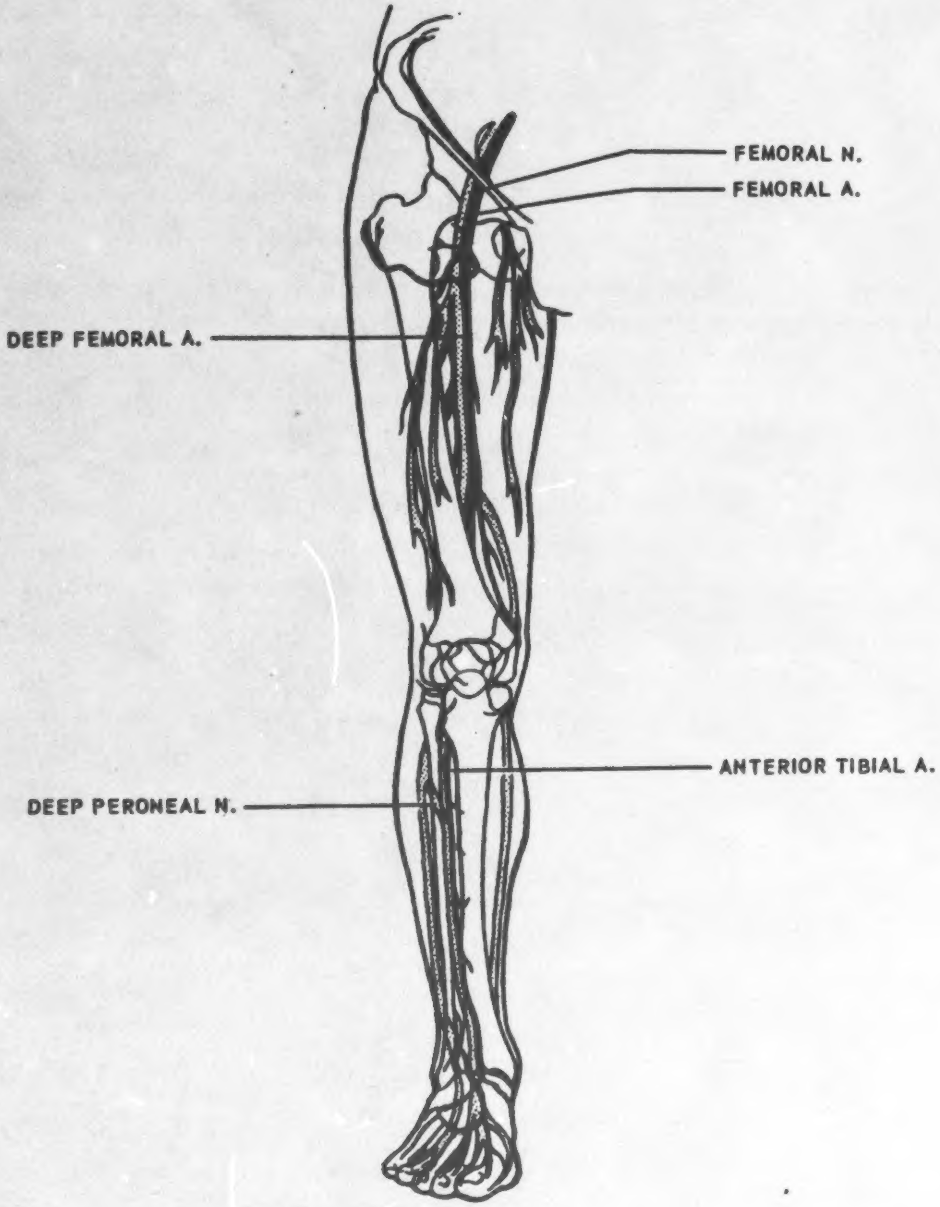
FEMORAL N.
FEMORAL A.
DEEP FEMORAL A.
ANTERIOR TIBIAL A.
DEEP PERONEAL N.

Figure 22. Nerves and blood vessels (major) of the upper and lower limbs indicating bony relationships.
Right lower limb, viewed from in front.

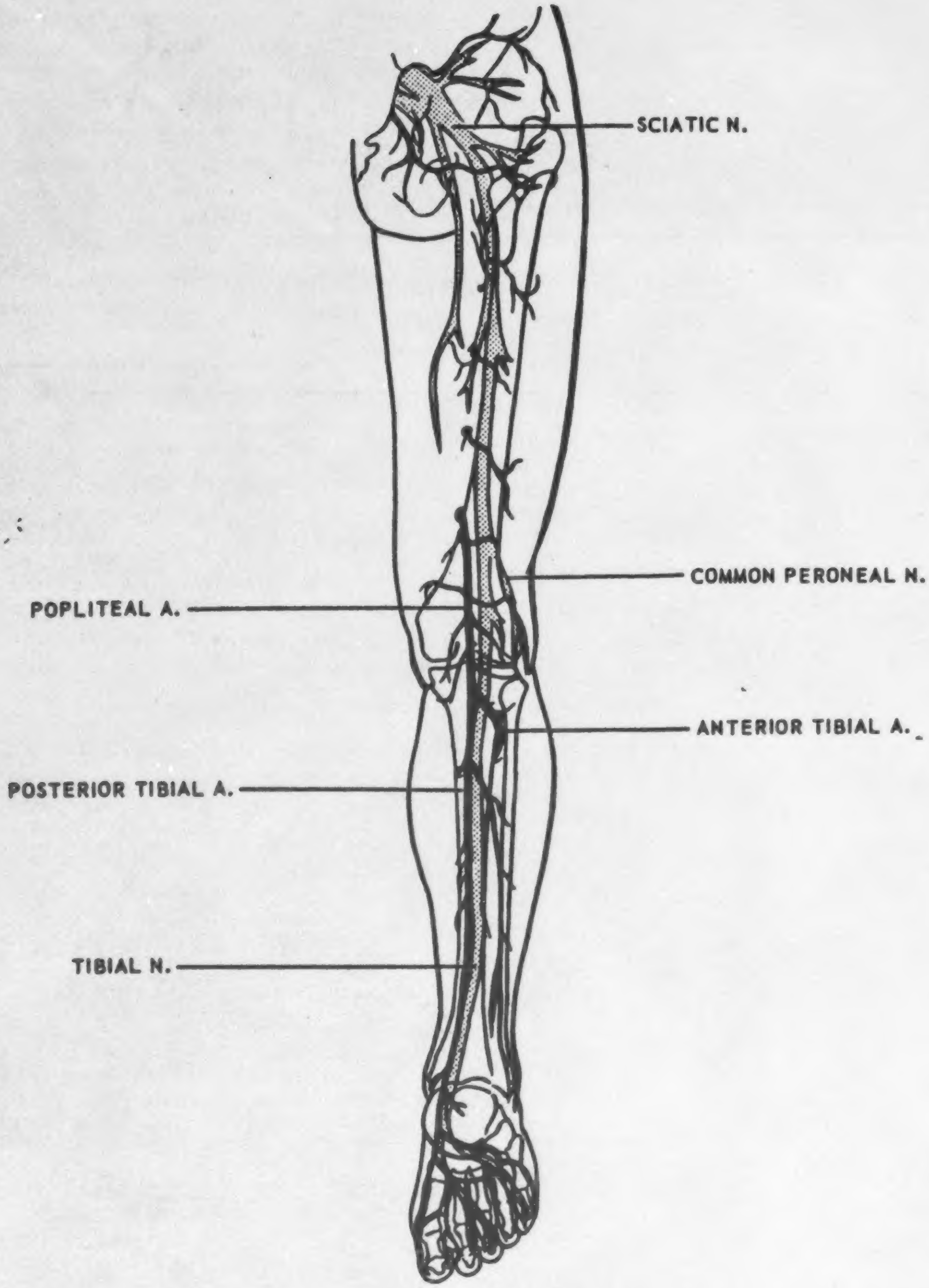
SCIATIC N.
COMMON PERONEAL N.
POPLITEAL A.
ANTERIOR TIBIAL A.
POSTERIOR TIBIAL A.
TIBIAL N.

Figure 33. Nerves and blood vessels (major) of the upper and lower limbs indicating bony relationships.
Right lower limb, viewed from behind.

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central nervous system to various parts of the body, such as muscles or glands. These impulses provide the stimulus for activation of these parts.

b. Nerves. A nerve is composed of one or more bundles of fibers bound together by connective tissue. Throughout their course nerves branch and fuse with other branches, yet each individual fiber remains distinct. Most nerves contain sensory and motor fibers and are known as mixed nerves. Injury to a nerve may prevent the transmission of impulses to or from body areas. Nerves of the peripheral nervous system will in some cases regenerate and restore normal transmission pathways. To accomplish recovery of a bruised nerve or damaged nerve, it must be handled with the greatest of care; otherwise, the injury may be permanent.

26. The Brain

The brain is composed of nerve cells and their processes or fibers. There are 12 pairs of cranial nerves many of which carry nerve impulses to and from the brain. They supply organs of the special senses and some muscles of the face, neck, thorax, and abdomen. The brain is divided into five parts: the cerebrum, midbrain, pons, cerebellum, and the medulla oblongata (fig. 34). The last three constitute the hindbrain.

a. The *cerebrum* is the part of the brain which controls the higher mental activities, such as memory, consciousness, and voluntary movements.

b. The *midbrain* serves as a connecting pathway between the right and the left halves of the cerebrum and also between the cerebellum and the rest of the brain.

c. The *pons* is a mass of white nerve tissue connecting the cerebrum, medulla oblongata, and cerebellum.

d. The *cerebellum* is the lower posterior area of the brain located between the occipital lobe and the pons. The function of the cerebellum is to control equilibrium, muscle tone, and mus-

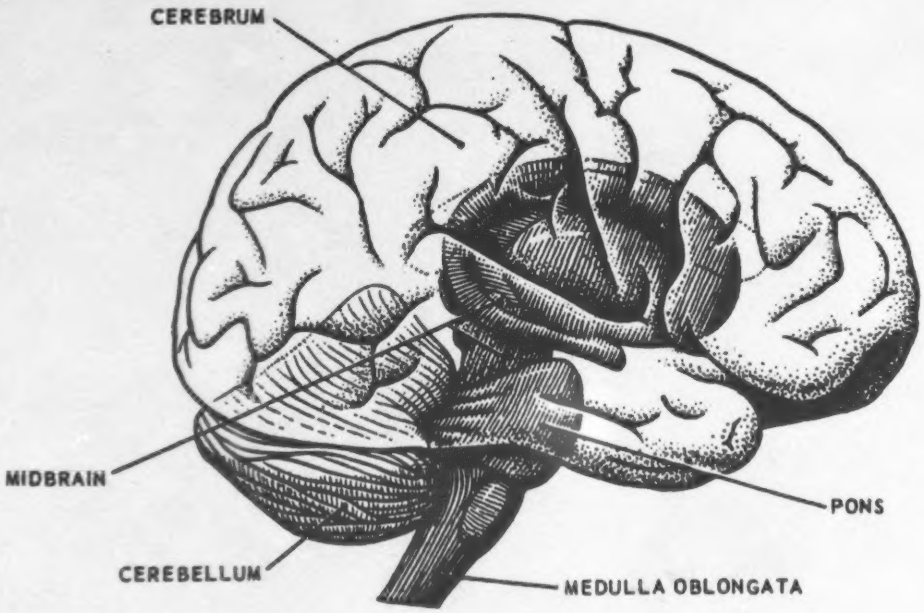

Figure 34. The brain.

cle coordination. Injuries in this region result in a lack of ability to control muscular movements.

e. The *medulla oblongata* is the lowermost part of the brain. It is continuous with the spinal cord distally. The medulla contains many vital centers, such as the center which controls the heart rate; the vasomotor center, which regulates the diameter of the blood vessels; and the respiratory center, which regulates the breathing rate.

27. Spinal Cord

The spinal cord, which is inclosed within the spinal canal of the vertebral column (para 10*a*(1)), extends from the medulla oblongata of the brain to the level of the disc between the first and second lumbar vertebrae.

a. The spinal cord is composed of nerve cells and their processes or nerve fibers. It has a covering of three membranes called meninges.

b. The spinal cord serves as a communicating pathway to and from the brain to various parts of the body, such as muscles, glands, and viscera. It also serves as a center for reflex actions. Each section of the cord is responsible for activities at a specific level of the body. Injuries to the cord may interrupt communication between the brain and parts of the body distal to the injured area. This interruption may result in partial or complete paralysis.

28. Spinal Nerves

From the spinal cord arise 31 pairs of nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. The function of the spinal nerves is to carry nerve impulses to and from the spinal cord. Both the spinal cord and the *roots* of the spinal nerves are inclosed within the spinal canal. The spinal nerves leave the spinal canal through the intervertebral foramina (para 10*a*(1)).

a. Each spinal nerve has a posterior root and an anterior root. As the nerve passes through its corresponding foramen, it divides into two rami, each of which contains fibers from both the posterior and anterior roots (fig. 35). The fibers that make up the posterior ramus supply all the structures of the *skin, fasciae, and the longitudinal muscles of the back*. The fibers that make up the anterior ramus supply all the structures of the *lateral and the anterior parts of the body and the limbs*.

b. In the cervical, lumbar, sacral, and coccygeal areas of the spinal cord, the anterior rami combine to form plexuses (networks of nerve fibers). The thoracic nerves, with the exception of the first, do not form a plexus, but are arranged so that each pair supplies a more or less specific segment of the body.

(1) The *cervical plexus* consists of the anterior rami of the first 4 cervical spinal nerves. Cutaneous branches from this plexus supply structures of the head, the neck, and the shoulders. One of the most important motor branches of this plexus is the *phrenic nerve*, which supplies the diaphragm and is very important to respiration.

(2) The *brachial plexus* consists of the anterior rami of the last 4 cervical and the first thoracic spinal nerves. It supplies structures of the upper limb. The chief nerves originating from this plexus are the *axillary*, the *musculocutaneous*, the *median*, the *ulnar*, and the *radial* (the largest).

(3) The *thoracic spinal nerves*, or intercostal nerves, provide nerve supply to the muscles and the skin of the abdomen and chest.

(4) The *lumbar plexus* consists of the anterior rami of the first 4 lumbar spinal nerves. It supplies motor fibers to muscles of the loin and part of the lower limb. The *femoral nerve* is the most important branch of this plexus.

(5) The *sacral plexus* consists of the anterior rami of the fourth and fifth lumbar and the first (and sometimes the second) sacral spinal nerves. It supplies part of the thigh, the leg, the perineum, and the gluteal muscles. The *sciatic nerve* of this plexus is the largest and longest nerve in the body (para 18*a*(1)).

(6) The *pudendal plexus* consists of the anterior rami of the third and fourth (sometimes the second) sacral nerves.

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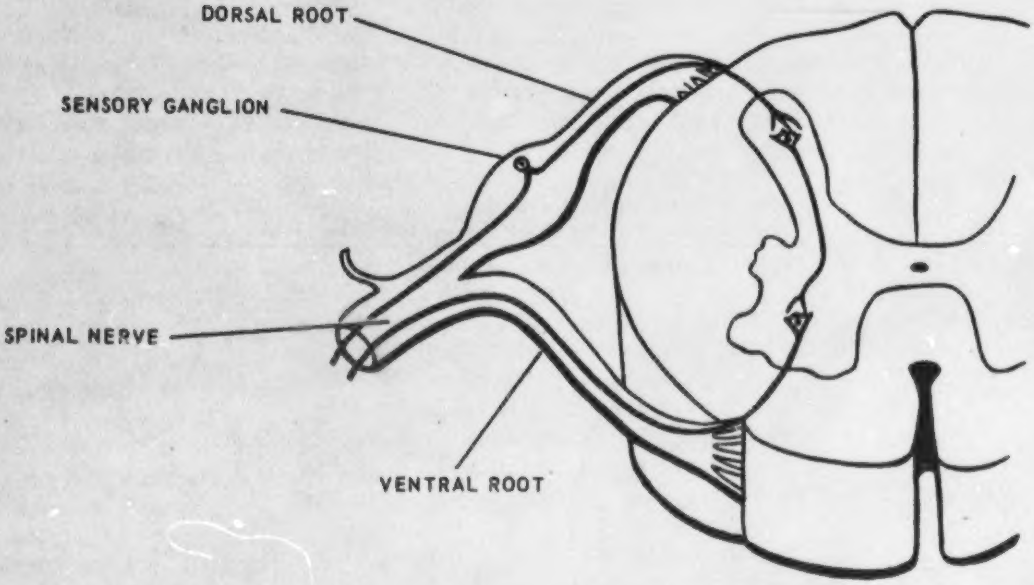

Figure 35. Formation of spinal nerve from spinal cord.

It supplies the levator ani muscle, the skin, and other structures of the perineum of its own side. The *pudendal nerve* is the largest branch of this plexus.

(7) The *coccygeal plexus* consists of the anterior rami of the fifth sacral and coccygeal nerves. It supplies skin and ligaments in the area of the coccyx.

29. Relationship of Nerves to Muscles

There is a nerve supply for each muscle of the body. It is usually through the action of its motor nerves that a muscle is brought into activity and its action coordinated with that of other muscles. Nerve endings associated with proprioception (position of muscles) are located in the muscular tissue or in the tendon of a muscle. These end organs serve to indicate the tension and movement of the muscles and the position of the limbs. This sense is important in determining the accuracy of body movements and the maintenance of balance.

Section III. MUSCULAR SYSTEM

30. General

Muscles constitute a large part of the soft tissues of the body. Muscles enter into the structure of many of the internal organs and form 40 to 50 percent of the body weight. There are three major types of muscle tissue: skeletal (also called voluntary or striated), smooth or involuntary, and cardiac or heart muscle tissue.

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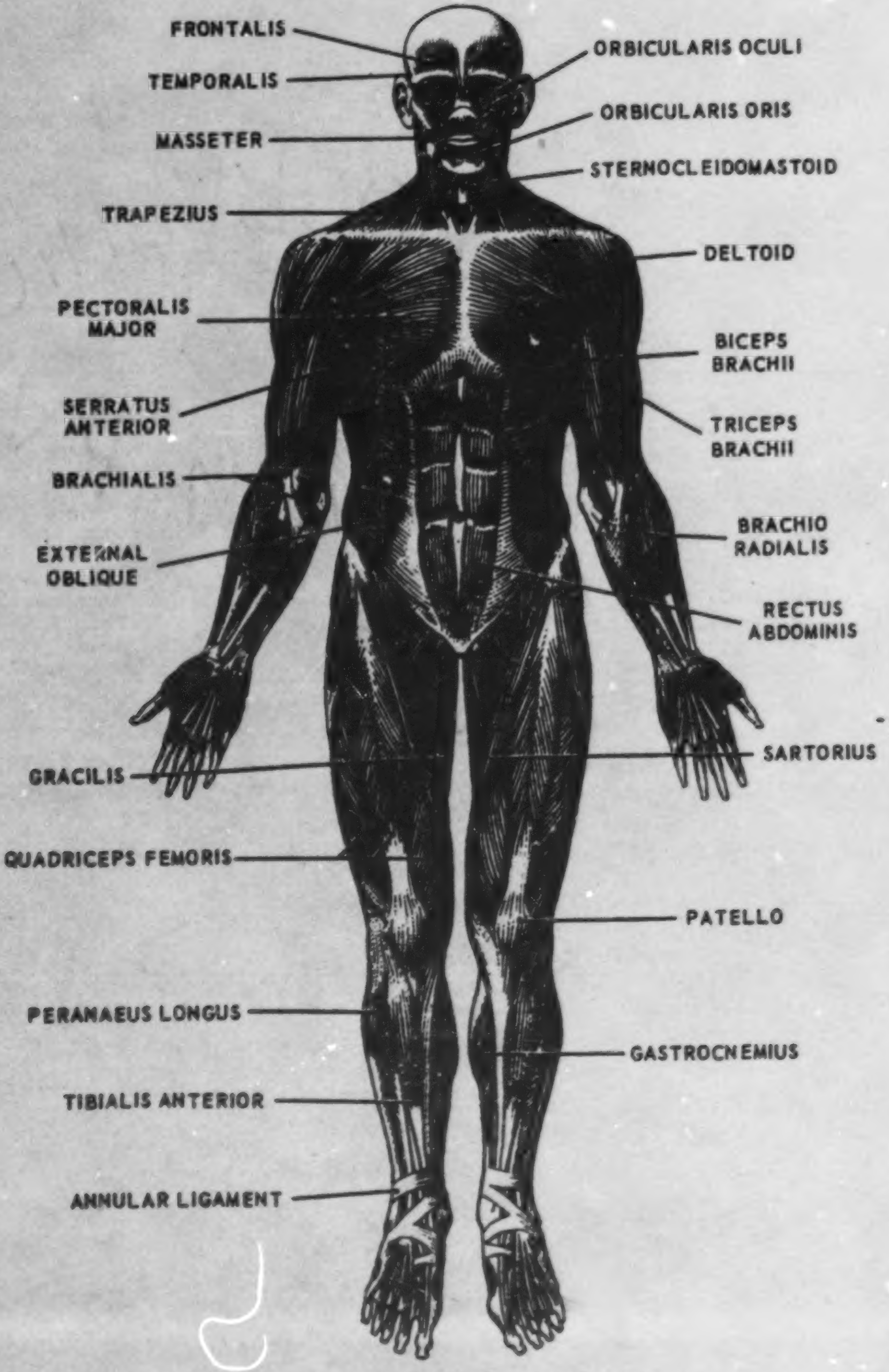
FRONTALIS
TEMPORALIS
MASSETER
TRAPEZIUS
PECTORALIS MAJOR
SERRATUS ANTERIOR
BRACHIALIS
EXTERNAL OBLIQUE
GRACILIS
QUADRICEPS FEMORIS
PERANAEUS LONGUS
TIBIALIS ANTERIOR
ANNULAR LIGAMENT
ORBICULARIS OCULI
ORBICULARIS ORIS
STERNOCLEIDOMASTOID
DELTOID
BICEPS BRACHII
TRICEPS BRACHII
BRACHIO RADIALIS
RECTUS ABDOMINIS
SARTORIUS
PATELLO
GASTROCNEMIUS

Figure 36. Skeletal muscles, anterior view.

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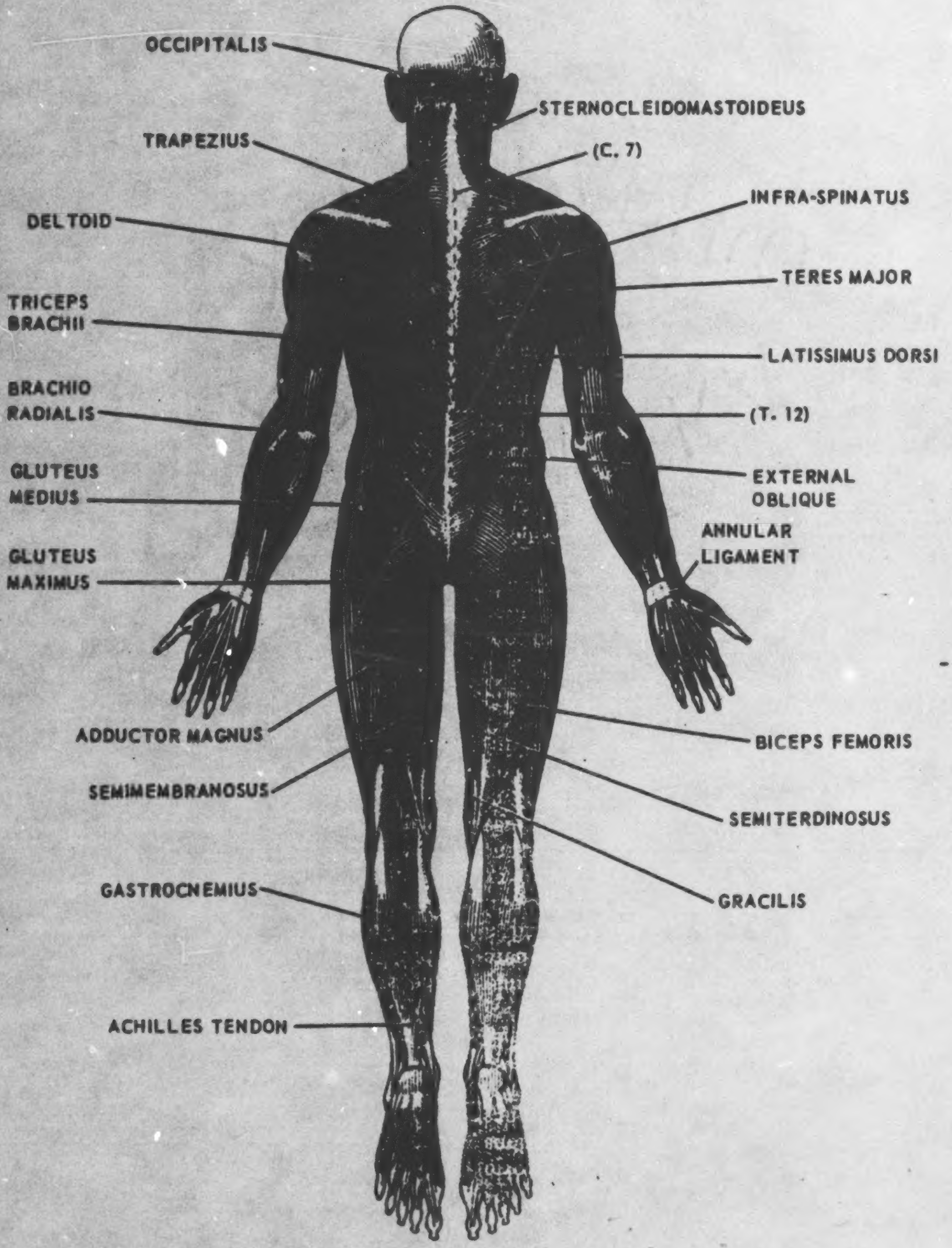
OCCIPITALIS
STERNOCLEIDOMASTOIDEUS
TRAPEZIUS
(C. 7)
INFRA-SPINATUS
DELTOID
TERES MAJOR
TRICEPS BRACHII
LATISSIMUS DORSI
BRACHIO RADIALIS
(T. 12)
GLUTEUS MEDIUS
EXTERNAL OBLIQUE
ANNULAR LIGAMENT
GLUTEUS MAXIMUS
ADDUCTOR MAGNUS
BICEPS FEMORIS
SEMIMEMBRANOSUS
SEMITERDINOSUS
GASTROCNEMIUS
GRACILIS
ACHILLES TENDON

Figure 37. Skeletal muscles, posterior view.

For purposes of this manual, only skeletal muscles will be discussed. All muscles which are attached at one or both ends to the bones of the skeleton are skeletal muscles (figs. 36 and 37). Skeletal muscles produce body movement. The action of skeletal muscles may be accelerated, slowed, or stopped as willed.

31. Structure of Muscles

a. The structural unit of a skeletal muscle is a muscle fiber. The functional unit consists of a nerve cell and the muscle fibers controlled by the nerve fibers of the cell.

b. Skeletal muscles are attached to bones by attachments composed of tendons. Tendons are made up of closely packed parallel bundles of nonelastic, dense fibrous tissue with a very small amount of areolar tissue separating the bundles. They are anchored into bone and form secure attachments of muscles. The tendons differ in shape in different muscles; some are round and thick and others are flat and thin. The flat, thin tendons are called aponeuroses. Tendons facilitate joint motion by replacing bulky muscle in their vicinity.

c. A skeletal muscle may be described anatomically as having a point of *origin,* where its attachment or attachments begin, and a point of *insertion.* The attachment of a skeletal muscle which is relatively fixed or stationary during use is known as the functional origin; the one which moves or could move during use is the functional insertion. During the movement of some muscles a reversal of function takes place; origin becomes insertion and insertion becomes origin.

32. Function

a. All motion, whether conscious or unconscious, depends upon the coordinated action of muscles. Even maintenance of posture depends upon this coordination.

b. For each group of muscles that produces one type of movement, there is another that produces the opposite type of movement in order to bring that particular part of the body back to its original position. The muscles that flex a joint are always being counterbalanced by those that extend that joint.

c. The normal functioning of muscles depends upon two equally important basic characteristics—contraction and relaxation.

(1) Muscles contract and produce the desired movement. The contraction of a muscle takes place when cells within the muscle contract by becoming shorter and broader. All cells within a muscle normally do not contract at once. The number of cells contracting at one time determines the degree and force of contraction of a muscle. Muscles that cannot contract are flaccidly paralyzed.

(2) Other muscles in the area help the movement to be smooth and regulated by their ability to relax or contract as needed. As muscles relax they become longer. Sometimes disease or injury to the brain or brain stem produces a condition in which muscles are said to be spastically paralyzed, that is, unable to relax.

d. Muscles are named according to the type of motion they produce; *for example,* the extensor muscles of the hand extend the hand, and the adductor muscles of the thigh move the thigh toward the body.

e. To keep muscles in place during movement, they are held together by layers of fibrous tissue called fasciae. The fasciae vary in density, structure, and thickness. In some places they form considerable masses.

(1) The superficial fascia lies immediately beneath the skin and usually contains considerable fat. Blood and lymph vessels and nerves of the skin are also found in it.

(2) The deep fascia is dense and tough. In many places sheets of it lie between adjacent groups of muscles, thereby permitting the different groups to act independently and still remain in place.

f. Each muscle has a nerve supply to maintain constant balance between opposing muscle groups and still permit coordinated movements. Motor nerves function to bring a muscle into activity (para 29).

g. In addition to the normal stimulation of muscles through the nerves, they may also by

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activated directly by mechanical or electrical stimulation and by application of heat and cold.

h. When a muscle contracts, a certain amount of energy is required. This energy is derived from chemical substances in the protoplasm of muscle cells which break down and produce toxic waste products. If these waste products accumulate, the phenomenon of fatigue results.

33. Muscles of the Back

The muscles of the back are divided into three layers: superficial, intermediate, and deep layers (fig. 37). The superficial group acts upon the shoulders; the intermediate group is respiratory in action; and the deep group acts upon the spinal column to keep the trunk in an erect position. The deep group also makes possible trunk movements from side to side, backward movements, and a moderate amount of turning.

34. Muscles of the Chest and Thorax

The muscles of the chest and thorax, including the diaphragm, are chiefly respiratory muscles. The diaphragm is the great dome-shaped muscle which separates the thoracic and abdominal cavities. The chest and thorax musculature assists in movements of the trunk, the neck, and the upper limbs.

35. Muscles of the Abdomen and the Inguinal Ligament

a. The muscles of the abdomen are the *external oblique* and *internal oblique, the rectus abdominis*, and the *transversus abdominis*. The rectus abdominis is vertically situated on each side of the median line of the abdomen within the fibrous aponeurosis of the oblique muscles. It extends from the symphsis pubis to the thoracic wall to help form the anterior wall of the abdomen. The other three muscles form the sides of the abdominal wall. They all assist in urination and defecation by compressing the abdominal viscera. They also assist in respiration and in flexion of the spine, and aid in lateral flexion and rotation of the spine.

b. The *inguinal ligament* is a thickened band of fibers of the aponeurosis of the external oblique muscle, extending from the anterior superior spine of the ilium to the spine of the pubis. Just above this ligament and parallel to it is the inguinal canal, through which pass the spermatic cord in the male and the round ligament of the uterus in the female. The inner opening in the transverse muscle is called the internal inguinal ring. The outer opening in the tendon of the external oblique muscle is called the external inguinal ring. These openings form weak places in the abdominal wall and are the frequent site of protrusion of part of the abdominal viscera, which is called a hernia or rupture.

36. Muscles of the Upper Limb

The muscles of the upper limb include those of the shoulder, the arm, the forearm, and the hand. The anteriorly placed muscles of the arm flex the forearm; those posteriorly placed extend it. The same principle applies generally to the muscles which arise from the bones of the forearm and attach to the bones of the hand and the fingers. Some of these muscles pronate the forearm, whereas other supinate the forearm (fig. 16). The muscles of the hand adduct, abduct, and circumduct the fingers and the thumb and assist in their flexion and extension.

37. Muscles of the Lower Limb

The muscles of the lower limb include those of the hip, the thigh, the leg, and the foot (figs. 36 and 37). The muscles on the anterior side of the hip flex the thigh on the abdomen. Those on the posterior side extend the thigh. Adduction of the thigh is brought about by the medially located muscles of the hip, whereas those on the lateral side abduct the thigh. The combination of these actions is called circumduction (fig. 22). The muscles of the posterior part of the thigh flex the leg on the thigh. Those of the anterior part extend the leg (fig. 25). The muscles having origin on the anterior surface and on the posterior surface of the bones of the leg flex, extend, and circumduct the foot. The muscles of the dorsal and the ventral surfaces of the foot extend and flex the toes, respectively (fig. 28).

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Section IV. CARDIOVASCULAR SYSTEM

38. General

The circulatory system consists of the heart, the blood vessels, and the lymphatics. Its function is to circulate blood to the tissues of the body, carrying food and oxygen to the tissue cells to be used in their metabolism and removing waste products of cell metabolism. The heart and blood vessels are also referred to as the cardiovascular system.

39. Heart

The heart is located in the anterior chest between the lungs with about two thirds of it to the left of the midline. The function of the heart is to pump blood continuously to all parts of the body.

a. The heart is divided into two separate halves, each acting as a pump. Each is divided into an *atrium* (upper part) and a *ventricle* (lower part). Each upper atrium is connected with the ventricle beneath it by an opening or *valve*. A third valve connects the right ventricle with the *pulmonary artery*, and a fourth connects the left ventricle with the *aorta artery*.

b. The heart is under the control of two sets of nerves which keep its activity in balance. They are the *vagus nerves*, which keep the heart beating at a slow regular rate, and the *accelerator nerves*, which speed up the heart rate.

40. Blood Vessels

Blood vessels consist of arteries, capillaries, and veins.

a. The system of arteries is similar to a tree, with a large trunk, the aorta, leaving the heart and giving off branches which repeatedly divide, becoming progressively smaller. Arteries are similar to hollow, elastic tubes. They have a nerve supply controlled by the autonomic nervous system, which permits enlargement or constriction of these vessels.

b. The final branches of the arteries are billions of tiny vessels called capillaries. The capillaries have very thin walls through which an exchange of food and oxygen and waste products takes place with the body's cells.

c. The system of veins is also similar to a tree with many branches which form major trunks (superior vena cava and inferior vena cava) back to the heart. Unlike arteries, veins have walls that are thin and collapsible, and they usually have paired valves preventing the backflow of blood.

41. Process of Circulation
(fig. 38)

a. The heart pumps blood to the body through the arteries into the capillaries. Nutriments and oxygen pass from the blood through the walls of the capillaries to the body's cells. At the same time waste products and carbon dioxide pass back into the capillaries. This exchange takes place by means of lymph, or tissue fluid, in the spaces between the cells of the tissue. Each organ withdraws materials needed for repair, maintenance, growth, and its own particular functions.

b. From the capillaries, the deoxygenated blood is carried back to the heart through the great veins (superior vena cava and inferior cava) and into the lungs.

c. The right side of the heart pumps the deoxygenated blood through vessels of the lungs. This is called the *pulmonary circuit*. Blood enters the right atrium and from there flows through the right ventricle, the pulmonary artery and its branches, and into the capillaries of the lungs. In the lungs the blood loses carbon dioxide and picks up oxygen. It then flows through the pulmonary veins to the left side of the heart.

d. The left side of the heart, which pumps the oxygenated blood through vessels of the body, is called the *systemic circuit*. Blood flows from the pulmonary veins into the left atrium and from there through the left ventricle. From the left ventricle it is pumped through the aorta and its branches back to the body tissues.

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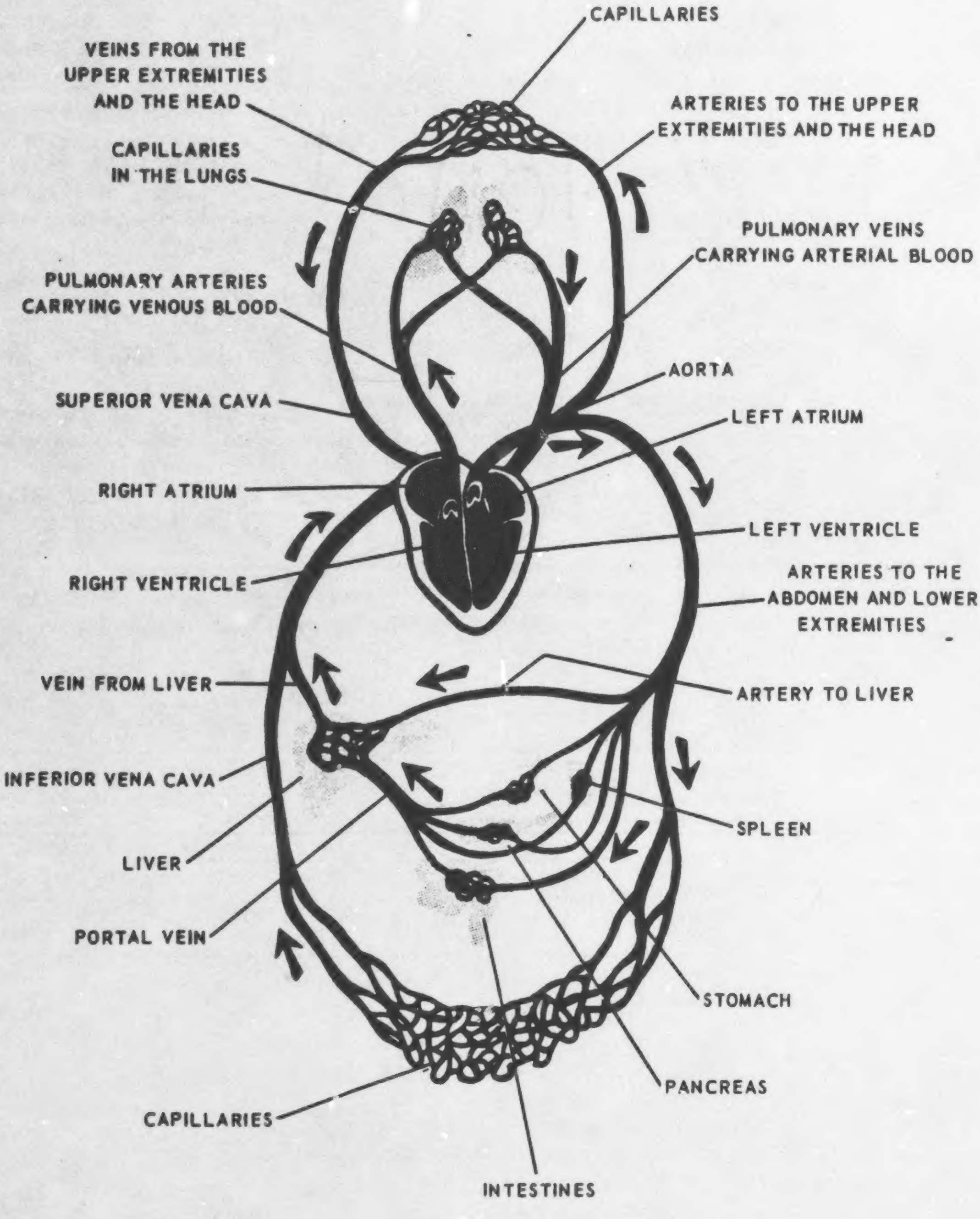
CAPILLARIES
VEINS FROM THE UPPER EXTREMITIES AND THE HEAD
ARTERIES TO THE UPPER EXTREMITIES AND THE HEAD
CAPILLARIES IN THE LUNGS
PULMONARY VEINS CARRYING ARTERIAL BLOOD
PULMONARY ARTERIES CARRYING VENOUS BLOOD
AORTA
SUPERIOR VENA CAVA
LEFT ATRIUM
RIGHT ATRIUM
LEFT VENTRICLE
RIGHT VENTRICLE
ARTERIES TO THE ABDOMEN AND LOWER EXTREMITIES
VEIN FROM LIVER
ARTERY TO LIVER
INFERIOR VENA CAVA
SPLEEN
LIVER
PORTAL VEIN
STOMACH
PANCREAS
CAPILLARIES
INTESTINES

Figure 38. Circulation of the blood (diagrammatic).

CHAPTER 3

PATHOLOGY

42. General

Pathology may be defined as that branch of medicine which deals with the essential nature of disease—its causes, processes, and effects. In this chapter only the diseases which commonly involve the duties of the orthopedic specialist will be discussed.

43. Arthritis

In his contact with the arthritic patient, the orthopedic specialist will soon learn that the treatment of arthritis is a slow and time-consuming procedure which may require the construction of many appliances and the changing of many casts. He will be called upon to exercise much tact and patience. Arthritis is a disease in which a joint or joints become inflamed. The different forms of arthritis may be classified according to causative factors.

a. Infectious Arthritis. Infectious arthritis is caused by the presence and multiplication of pathogenic bacteria in one or more joints. Usually, it is an acute disease with a fairly rapid onset and rapid progression of signs and symptoms. In acute infectious arthritis, pyogenic bacteria, such as streptococci from a sore throat or pneumococci from pneumonia, commonly invade the joints via the bloodstream. Much pain, much swelling, and considerable fever are characteristic of the disease.

b. Possibly Infectious Arthritis, Etiology Unknown. Within this category of arthritis there are a number of arthritic processes which have systemic manifestations and usually affect many joints. The chief examples are rheumatoid arthritis, which is the crippling form of the disease, and arthritis of rheumatic fever, which in addition to its arthritic components has a very important accompanying pathology involving the heart. Rheumatoid arthritis is characterized by inflammation of the joint structures and surrounding tissues which leads to muscle and bone atrophy and deformity of the joint. It often begins in the metacarpophalangeal and proximal interphalangeal joints of the hands and later spreads to involve the larger joints of the body. In arthritis of rheumatic fever, the large joints become involved, one after another.

c. Degenerative Joint Disease or Osteoarthritis. This is probably the most common form of arthritis. It usually results from the aging of joints and tends to increase in severity with age and to affect joints that are subject to much stress. It is characterized by atrophy and degeneration of the joint cartilage with hypertrophy or overgrowth of bone margins. It may begin in the distal interphalangeal joints of the hand and appear later in the weight-bearing joints, such as the joints of the lumbar spine, cervical spine, hips, and knees.

d. Traumatic Arthritis. Traumatic arthritis usually results from a specific joint injury or injuries which have deformed the joint or its ligaments and caused it to function abnormally. The accelerated wear and tear which results causes the joint to be painful and swollen and may severely limit its function. Surgery, such as arthrodesis or arthroplasty, may be required.

e. Arthritis of Gout. This is a disorder associated with a disturbance of body metabolism which manifests itself in a form of arthritis. Patients with this form of arthritis are seldom seen by the orthopedic specialist, since they are usually treated by medication alone.

44. Bursitis

In areas of the body where muscles or tendons pass over bony prominences, the body has developed bursae to protect the areas from

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friction and wear. Bursae are little sacs normally containing a small amount of fluid, which serves to reduce friction and wear on the bone. Occasionally bursae become inflamed from wear or bacterial infection, and the result is a great increase in the amount of fluid in them. Since they do not have an outlet, the large quantity of fluid is under pressure and the pressure causes pain. Immobilization by means of plaster may be used as a temporary measure to rest the part and reduce the swelling. When braces are prescribed, they must be made so that they will not exert pressure on the bursae.

45. Aseptic Necrosis (Avascular Necrosis)

Aseptic necrosis is a phenomenon which occurs in bone. Its exact cause is unknown. It is thought to be the result of interruption of the blood supply to an area of the bone, most commonly an epiphysis or the site of a former epiphysis. The result of this condition is the gradual disintegration and death of the bone and finally the collapse of the structure. Since this involves primarily epiphyseal areas, the final result is usually varying degrees of deformity of the joint surface, to which the body responds by developing traumatic arthritis. One form of this disease in children is called Legg-Calvé-Perthes disease, in which the epiphysis of the head (proximal end) of the femur undergoes degeneration. Collapse and deformity of the bone usually results unless the bone is prevented from bearing weight. Another form of the disease follows fractures of the neck of the femur. The head of the femur, being separated from its blood supply by the fracture, dies and collapses, and extensive treatment is required.

46. Epiphyseal Growth Disturbances

In the growing child, bones contain separate centers of growth, called epiphyses, which are joined to the main body of the bone by cartilage plates. Later the epiphyses become a part of the long bone. These centers may be found at the ends of the long bones and at the points of muscular attachment in many of the flat bones and some of the long bones (fig. 39). The growth function of these centers can be disturbed by severe systemic diseases, vitamin deficiencies, some metal poisoning, and injury. The most common causative factor with which the orthopedic specialist will be involved is injury.

a. When an epiphysis is injured by a fracture which passes through it or a part of the bone adjoining it, the growth center may cease to function prematurely and join with the main body of the parent bone. When this happens the usual result is a shortened bone in the adult, such as a shortened leg or arm. Occasionally only a part of the growth center is damaged, resulting in a cessation of growth of only the damaged part. The undamaged part of the epiphysis continues to grow with the result that the joint adjacent to the growth center becomes distorted and deformed as illustrated in figure 40. Surgery is often required, followed by bracing and shoe correction until growth ceases.

b. When an epiphysis has a fracture near it, it may be stimulated to overgrowth, and the arm of leg involved becomes longer than the one on the opposite side.

47. Fractures

a. General. A fracture is a complete or incomplete break in the continuity of a bone. A fractured bone may be broken into two or more separate fragments of bone, or it may be only "cracked." It may be a simple fracture with one break in the bone, or it may be a *multiple* (*comminuted*) fracture, in which the bone is fractured at more than one site.

(1) A fracture may be produced by direct violence applied to the bone causing it to break, or it may be caused by indirect violence applied to the bone—*for example,* a fall with weight on an outstretched hand, causing a fracture of the head of the radius. Many diseases, such as parathyroid disease, syphilis, and bone tumors, can gradually weaken a bone to the extent that only a slight stress can cause a fracture or fractures. Fractures of this type are called *pathological fractures.*

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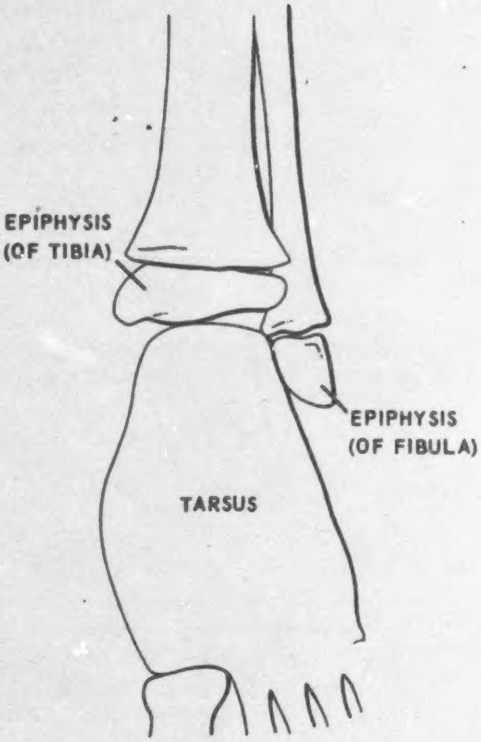
EPIPHYSIS
(OF TIBIA)
EPIPHYSIS
(OF FIBULA)
TARSUS

Figure 39. Tibia with epiphyses open and normal growth occurring.

(2) Fractures are generally classified as closed or open. A *closed fracture* consists of a break in the bone without a break in the exterior surface of the skin. An *open fracture* is a break in the bone that communicates with the exterior surface of the skin. In an open fracture, the bone may penetrate the skin or the bone may be exposed in wounds, such as one produced by a shell fragment or bullet. Open fractures are likely to be contaminated by pyogenic organisms; however, the mortality rate from this type of injury is low if treatment is prompt and measures are taken to prevent shock and infection.

b. Types of Fractures (*fig. 41*). Fractures may be classified according to position, number, and shape of bone fragments.

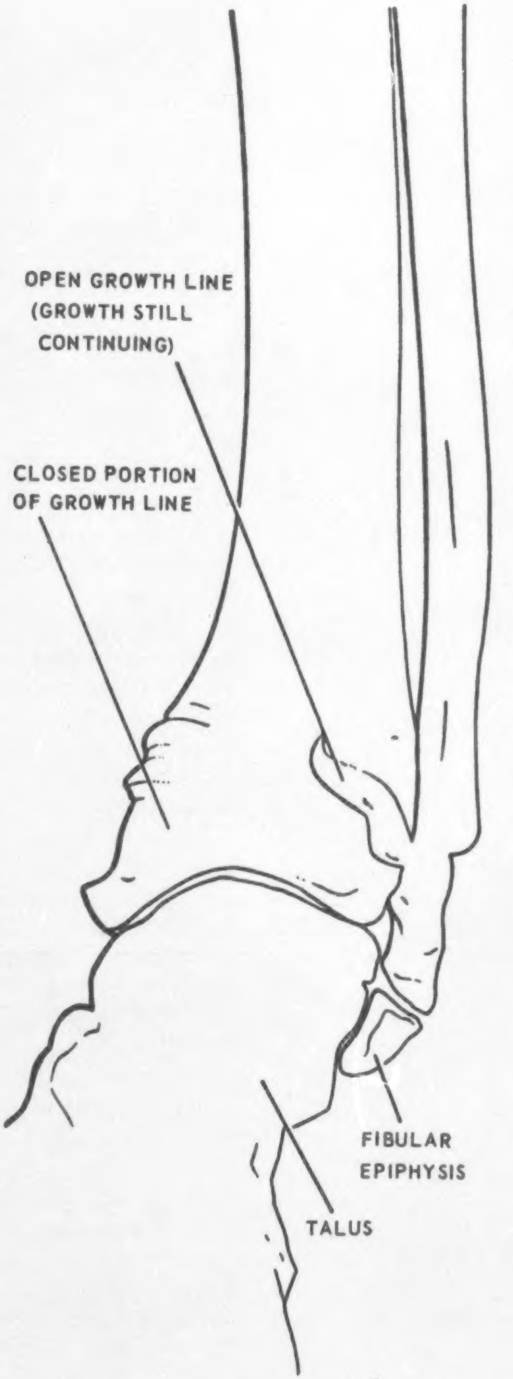
OPEN GROWTH LINE
(GROWTH STILL
CONTINUING)
CLOSED PORTION
OF GROWTH LINE
FIBULAR
EPIPHYSIS
TALUS

Figure 40. Premature closure of medial part of tibial epiphysis (distal) with resultant varus of ankle joint.

(1) In the *transverse fracture*, the fracture line is more or less at right angles to the long axis of the bone. It is usually produced by an angulation force.

(2) An *oblique fracture* is one in which the fracture line extends obliquely across the bone and fragments of the bone tend to slip by each other. It is usually produced by a twisting force.

(3) In the *spiral fracture*, the fracture line is spiral or S-shaped. These fractures are produced by twisting injuries of the type seen among ski troops or by torsion produced by muscular contraction.

(4) In a *longitudinal fracture*, the fracture line splits the bone lengthwise.

(5) The *greenstick fracture* is an incomplete fracture which is caused by a compression force in the long axis of the bone. Usually the convex surface breaks, while the concave surface remains intact. This type of fracture is most common among children, in whom bones are more elastic than in adults.

(6) A *compression fracture* is one in which bones are compressed; *for example*, one or more of the lower dorsal or upper lumbar bodies of the spinal column may be compressed as the result of a blow. It is usually produced by severe violence applied to cancellous tissue.

(7) A *depressed fracture* is one which a fragment is driven below the surface of the bone. This type of fracture occurs in flat bones, such as the skull.

(8) In an *impacted fracture*, the broken ends are jammed together, so that they more or less telescope into each other. This fracture is produced by a violent force driving the bone fragments firmly together.

(9) In the *comminuted fracture*, which is produced by severe direct violence, there are three or more fragments. Reduction is difficult to maintain in this type of fracture, and associated soft tissue injuries are frequently severe.

c. Complicated Fractures. A break in the bone is always associated with injury to the soft tissue structures near the fracture. This includes the periosteum, muscles, tendons, nerves, and vessels. Sometimes fractures caused by severe violence may be complicated by injury to nerves, arteries, or organs at a distance from the site of the fracture; *for example*, a fracture of the long bone may be complicated by fat emboli to the lungs.

48. Osteomyelitis

Osteomyelitis is an inflammation of the bone and the bone marrow caused by bacterial infection. The inflammation attacks the soft parts of the bone, including the marrow, and results in the dissolution of calcium in the compact or dense, hard bone. The hard bone becomes soft, and varying amounts of bony tissue are destroyed. Systemic reactions include fever, pain, swelling, and other evidence of general infection. Advances in surgery and drug therapy have made it possible to decrease the incidence of death as a result of osteomyelitis. The chief results of the disease are now deformity, weakness of the bone, and at times draining sinus tracts through the skin. The bones most frequently affected are the femur, tibia, and humerus.

a. When osteomyelitis is caused by bacteria brought to the bone by the bloodstream it is called *hematogenous osteomyelitis*. Bacteria from some existing infection within the body—*for example*, a boil or furuncle—spread, traveling along the course of the blood vessels to the bone. They may lodge in soft tissue, producing an abscess, or in the capillaries inside a lone bone. In *traumatic osteomyelitis*, bacteria reach the bone directly through an open wound or fracture and cause infection. The affected bone may continue to drain for many months or years and require surgery. In the military setting, osteomyelitis from trauma is

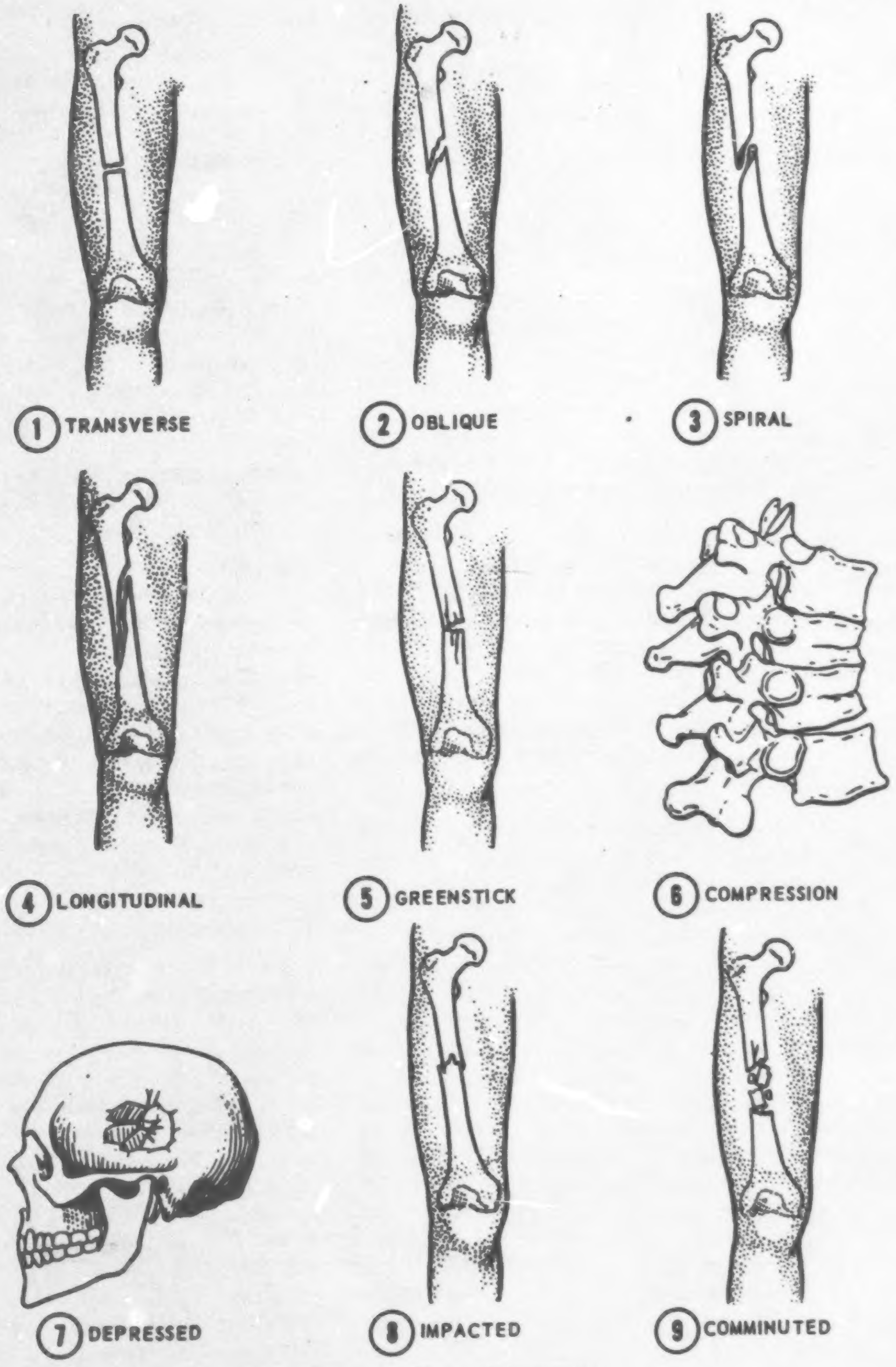
1 TRANSVERSE
2 OBLIQUE
3 SPIRAL
4 LONGITUDINAL
5 GREENSTICK
6 COMPRESSION
7 DEPRESSED
8 IMPACTED
9 COMMINUTED

Figure 41. Types of fractures.

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more common than is hematogenous osteomyelitis.

b. Because of the need for protecting the damaged bone, the orthopedic specialist will frequently be called upon to participate in the treatment of osteomyelitis by helping with cast changes and brace fittings.

49. Vitamin Deficiencies

The human body responds to lack of vitamin intake or faulty metabolism of vitamins with many manifestations of a systemic nature involving many different organ systems. Two vitamin deficiencies are of especial importance to the orthopedic specialist because of the role he may play in the care of patients with manifestations resulting from these deficiencies.

a. Vitamin C Deficiency (Scurvy). The common natural sources of vitamin C are citrous fruits and green leafy vegetables. Deficiency of vitamin C is seen most commonly in infants who have had a deficient diet and in prisoners of war who have been deprived of foods containing this vitamin. Severe bone deformities and a tendency to hemorrhage are a result of vitamin C deficiency. Bracing may be required during treatment.

b. Vitamin D Deficiency (Rickets). Vitamin D is found naturally in eggs, milk, some meats, and in fish liver, but adequate metabolism of this vitamin also requires exposure to sufficient amounts of sunlight. Vitamin D deficiency is most commonly seen in infants and young children who have had a deficient diet. In the United States, in addition to seeing that a child has an adequate diet, many physicians prescribe additional doses of this vitamin in drop form. Deficiency of vitamin D exerts profound effect on the normal development of bone and its growth, and may result in severe deformity. In some persons abnormality in metabolism or excretion of this vitamin results in a more or less chronic state of mild rickets. Both types of patients require considerable brace and cast work to prevent or reduce deformity while they are being treated with medications.

50. Neoplasms

Neoplasms, or tumors, are new growths which are generally classified as benign or malignant, depending upon their behavior in the location of their origin. The locomotor system of the human body is subject to many tumors which originate in muscle, bone, joint capsule, cartilage, and fibrous tissue.

a. Benign. Benign tumors are defined as "not recurrent" or "favorable for recovery." A benign tumor does not invade the tissue in which it is growing, but pushes it aside and continues to grow in the area where it originated. It does not spread to distant parts of the body, and if completely removed from the place where it originated, it does not usually reappear in that area. Examples of these tumors are the common mole of the skin and the fibroma or fibrous tumor of connective tissue.

b. Malignant. A malignant tumor is a type of lesion which is characterized by invasion of the tissue in which it originates, by spreading without definite boundaries, and by a tendency for cells of the tumor to break off and travel through the bloodstream or lymph vessels to other organs or tissues remote from the point of origin. Most malignant tumors seen in orthopedics are called sarcomas. They are treated most frequently by amputation or very extensive resection of a part of the locomotor system.

51. Torticollis

Torticollis, also called wryneck, is a condition characterized by a tilting of the head from the normal horizontal level of the eyes (fig. 42). It is more common in young patients, particularly girls. Usually the cause of torticollis is unknown. Occasionally the cause is an asymmetrical development of the cervical vertebrae present from birth and very difficult to correct. A common cause is contracture of the sternocleidomastoid muscle in the neck with rotation of the head toward the opposite side and tilting of the level of the head toward the same side. The constant muscle pull on the skull frequently results in a flattening or deformity of the face. A fairly common, short-duration form of torticollis involves minor inflammation of the neck muscles such as that which may accompany colds or deep-seated infections of structures in the neck. It is seldom seen by the orthopedic specialist, since it is of short duration and does not require the application of casts or appliances. The orthopedic specialist will be involved in the more serious forms of torticollis when plaster jackets or braces are applied following corrective surgery.

52. Low Back Pain

There are many causes and types of low back pain. Only those which the orthopedic specialist is likely to encounter in the performance of his duties will be included in this paragraph.

a. Neurological Causes. Low back pain from neurological causes is associated with herniation of the intervertebral disc (fig. 43), which lies between the bodies of the vertebra (para 10a(1), fig. 7). The intervertebral disc sometimes ruptures under stress due to wear and tear, and a part of its soft interior protrudes outside the normal limits of the bodies of the vertebrae. If this protrusion happens to go anteriorly away from the spinal cord, the patient may have few or no symptoms. Often the disc protrudes in a posterior lateral direction, exerting pressure on the spinal cord itself or, more often, on one of the nerves as it is about to leave the spinal canal through its corresponding intervertebral foramen (para 10*a*(1)). When this occurs the result is pain which may be quite severe and often runs down the leg or arm roughly in the course of the nerve involved. Herniation of an intervertebral disc may occur at any level of the spine, but it occurs more frequently in the lower lumbar area, probably because of the greater stress this area is called upon to bear. Many patients with this condition respond to treatment with rest, but surgery for removal of the offending herniated disc is a commonly accepted form of treatment, and braces are sometimes prescribed.

b. Mechanical Causes. Probably the largest number of patients with low back pain are included in this category. Poor posture is one of the most common mechanical causes. Constant poor posture causes continuous strain on the ligaments, which respond by causing pain. Another mechanical cause is arthritis, either of the degenerative type or of the traumatic type following fractures of the vertebrae. Sometimes congenital defects of the vertebrae causing mechanical deformity of the back are described as causes for low back pain. A common example is the pedicle defect or a disruption of the part of the vertebra connecting the laminae and the body. Mechanical defects involving a congenital hemivertebra (incompletely developed on one side) throw severe stresses on the vertebrae and lead to pain. Another congenital defect which may coexist with low back pain is the "spina bifida occulta," which is a failure of the neural arch to form completely and roof-over the spinal canal. Many authorities deny that this is a cause of back pain, since many patients who have this defect do not have back pain symptoms. Occasionally, treatment for low back pain from

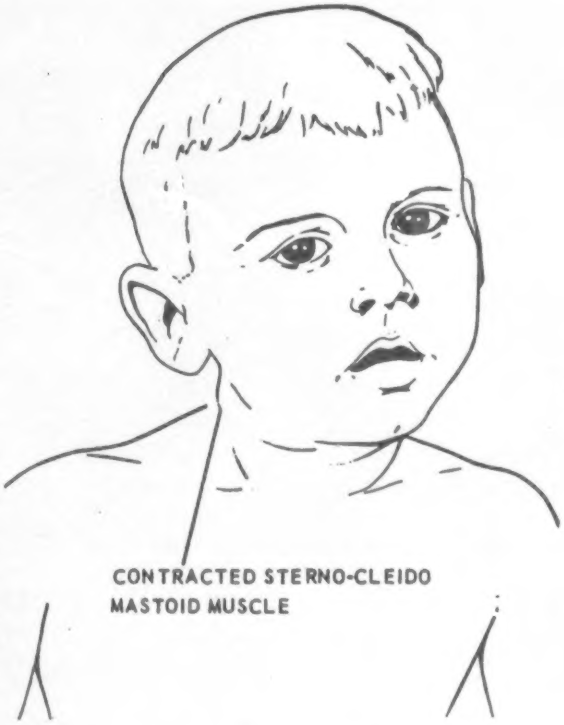

Figure 42. Patient with torticollis.

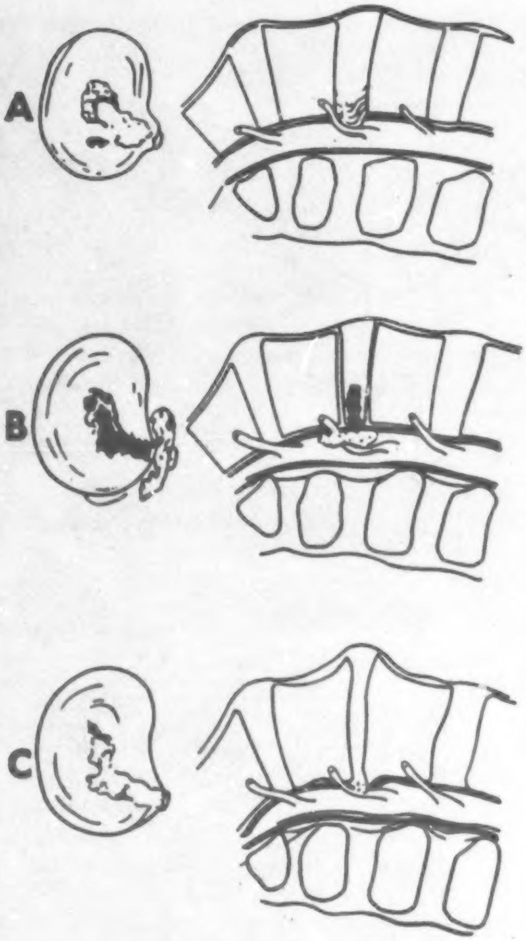

Figure 43. Herniated nucleus pulposus in area of intervertebral foramen.

mechanical causes is surgery, the most common form being arthrodesis of a part of the spine to prevent the pain-causing motion. Many varieties of braces and supports may be prescribed for patients with low back pain in this category.

53. Spinal Deformities

The upright posture of the spine is controlled by the shape of the vertebrae, by the ligaments which run between the vertebrae, by the discs between the vertebrae, and by a fine balance between the muscles of the abdomen and back and between those of the right and left sides of the trunk. An affection of any of these structures will therefore affect posture. As indicated in chapter 2, most of the spine motion takes place in the cervical and lumbar areas, a slight amount if the thoracic area, and none in the sacral area.

a. Normal Curvatures of the Spine. The spine has four normal curvatures which counteract or balance each other. The cervical (neck) area has its convexity forward, the thoracic (chest) area curve is backward, the lumbar (abdominal) convexity is forward, and the sacral (pelvic) curve is backward.

b. Lordosis. Lordosis is an abnormal forward curve of the cervical and lumbar areas, usually the lumbar area. It is commonly referred to as swayback. It is usually secondary to deformities of the hips, muscular dystrophy, or shortening of the Achilles tendon.

c. Kyphosis. Kyphosis is an abnormal backward curve or posterior convexity, of the thoracic and sacral areas, usually thoracic. It is commonly referred to as hunchback.

d. Scoliosis (fig. 44). Normally, there is no sideward curvature of the spine. An abnormal sideward curve is referred to as scoliosis. It is called left or right scoliosis, depending upon the direction of the convexity. There are three principal types of scoliosis, based upon causative factors.

1. *Structural scoliosis* is due to the abnormal shape or structure of one or more vertebrae. This may be present at birth, it may follow infection or injury, or it may develop gradually because of persistent faulty posture.
2. *Paralytic scoliosis* is due to muscle paralysis; *for example,* if the back or abdominal muscles on the right side are paralyzed by poliomyelitis, they can no longer maintain the spine straight and a right scoliosis develops.
3. *Idiopathic (cause unknown) scoliosis* is the type seen in adolescents, most commonly in girls. For some of these patients the only solution is an opera-

tion to fuse the involved vertebrae to each other. It is generally conceded that, with the exception of the Bount or Milwaukee brace, braces cannot correct this type of scoliosis. In some patients, it is impossible to prevent progression of the deformity and it continues until spine growth has been completed.

54. Paralysis

a. General. All body motion depends upon the coordinated action of muscles and automatic nerve control over the muscles to maintain constant balance between opposing groups of muscles and still permit coordinated movements (para 29). A muscle may become paralyzed by disease or injury. When this happens the balance between opposing groups is upset, causing impairment or disruption of the normal motion of the related body part and a possible deformity of the part. Examples of orthopedic conditions resulting from muscle paralysis are the following:

(1) *Knee flexion contracture.* To bend the knee not only must the hamstrings (flexor muscles on posterior of thigh) tighten but the quadriceps femoris (extensor muscles on anterior of thigh) must relax. Because muscles are never completely relaxed, if the knee extensors are paralyzed the knee flexors will automatically pull the knee into flexion. If the knee is permitted to remain in the flexed position for a period of days the fibers of the knee flexors shorten and the patient has a *flexion contracture,* or a shortening of the soft tissue structures of the joint, which limits its range of motion.

(2) *Foot deformity.* Ankle and foot motion takes place in four directions—up, down, inward, and outward (para 23*d*, fig. 28). Six principal muscles perform these actions. Of these the gastrocnemius and soleus (at calf or leg) are concerned only with true ankle joint motions. The other four move the subtalar and the midtarsal

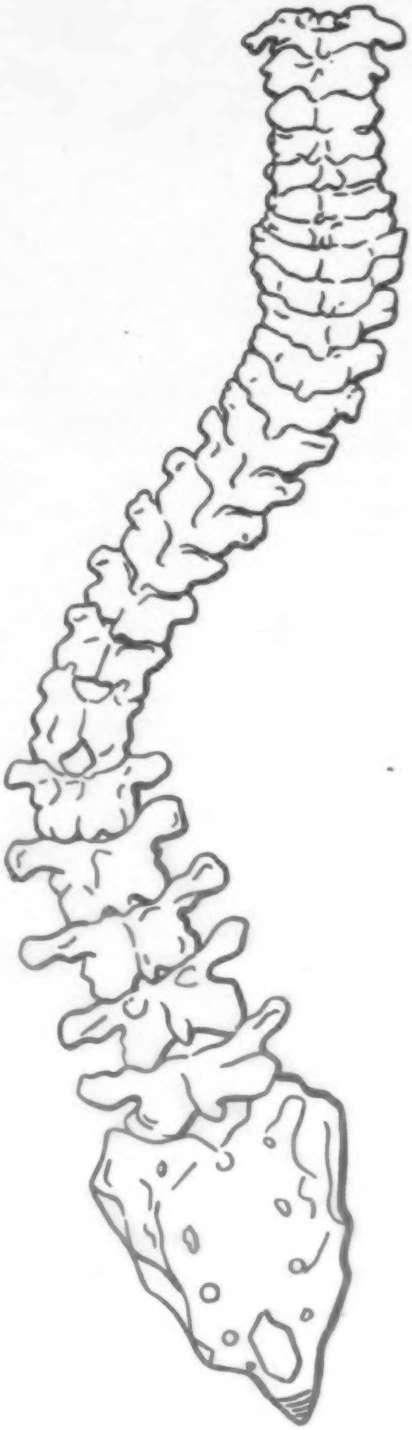

Figure 44. Scoliosis of "S-curve" type.

joints, as well as the true ankle joint. The relative strength and actions of all six must be accurately balanced to permit normal function. When even one of these muscles is partly or completely paralyzed, this balance is upset and a foot deformity may develop.

b. Paralysis, Post-Poliomyelitis. Poliomyelitis is a disease causing muscular paralysis. Poliomyelitis may affect some muscles more than others, upsetting the fine balance necessary for normal function of any joint. This is particularly noticeable in the weight-bearing joints (the trunk and the limbs). In paralytic conditions, bracing is used to obtain as near normal function as possible while preventing the development of deformities.

c. Paralysis, Traumatic. Another common cause of paralysis is trauma. This may take the form of an injury to the spine with severance of all or a part of the spinal cord. All the muscles below the level of the injury are paralyzed, since nerve impulses reach the muscles from the brain by way of the spinal cord. Injuries to the separate nerves of the limbs by various wounds or pressure from injuries or tumors also cause interruption of the transmission of nerve impulses from the central nervous system to the muscles, resulting in paralysis of the particular muscles innervated by that nerve. This is very similar to the failure of a cut or broken electric wire to transmit current. Repair of injuries to the nerves frequently results in return of some or all function after a long enough period has elapsed for the nerve to re-grow from the level of the injury repair to the muscles which it supplies. Bracing to maintain a functional position of limbs and to prevent contracture is necessary in almost all cases.

55. Congenital Dislocation of the Hip

The ball and socket structure of the hip joint permits a wide range of motion which is exceeded only by the shoulder joint. A great stability is provided by the close fit of the femoral head into the acetabulum (os socket) and its deepening lip, by the rim of fibrocartilage attached to the rim of the socket, and by the support of strong capsular ligaments and heavy musculature. Congenital dislocation of the hip is partial or complete displacement of the head of the femur from the acetabulum. This condition is manifested by a limp when the child begins to walk. Treatment consists of the application of a hip spica cast used as a brace to hold the hips in wide abduction. This is used for many months in children under 3. Older children usually require surgery.

56. Clubfoot

Talipes (clubfoot) is a congenital disease which has many forms. The most common forms of foot deformities are illustrated in figure 45. Two of these terms—varus (bending inward) and equinus (toes only touch ground) —frequently combine to form a term which describes the particular deformity a patient has, *for example,* "talipes equinovarus." This is a combination of the two types—"talipes equinus" and "talipes varus."

a. All forms of clubfoot if untreated result in the patient using the foot much like a club when walking. Clubfoot is usually treated immediately in the newborn. The most common form of treatment is the molding of the foot by repeated cast changes; however, some orthopedists achieve good results by the application of braces and splints. In its more resistant forms clubfoot may require extensive surgery and prolonged use of braces and shoe alterations.

b. The treatment of clubfoot concerns the orthopedic specialist since much of the work done by the specialist in assisting the orthopedist is in the larger hospitals where many of the patients are children.

57. Foot Ailments

a. Flatfoot. Pes planus, or flatfoot, is one of the most common forms of foot abnormalities. It is characterized by a longitudinal arch that is lower than normal, which causes the foot to "toe-out" and carry most of the weight on the inner border of the foot when in the act of walking. If flatfoot is untreated for many years during childhood while the foot is growing, the

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bones will often grow into the shape dictated by the deformity. For this reason, in many types of flatfoot, children should wear arch supports and corrective shoes until the feet have completed their growth (age 15 or 16). Flatfoot may be caused by any congenital or acquired abnormality which alters the shape of the bones of the longitudinal arch, affects the muscles which hold up this arch (particularly the anterior and posterior tibial muscles), or reduces the efficiency of the plantar ligaments. Acquired flatfoot can be caused by fractures, dislocations, poliomyelitis, muscle imbalance, over-correction of a clubfoot, and diseases such as arthritis and poliomyelitis. Flatfoot may be classified according to severity in many ways. The classification used by the Army is mild, moderate, or severe. From the clinical standpoint there are three types: flexible, spastic, and rigid.

(1) The *flexible flatfoot* is congenital in origin. It is never fixed in degree, varying from the faintest suggestion of flatfoot to the most severe. The patients who develop symptoms will show shortening of the heel cord, so that the foot cannot be dorsiflexed beyond an angle of 90 degrees. This type of foot is entirely flexible and looks nearly normal, except when it is weight bearing; it is only in a standing position that it goes into flatfoot deformity.

(2) The *spastic flatfoot* is caused by any condition which will put the peroneal muscles into spasm, such as arthritis of the subtalar joint, infections in the region of the peroneal muscles, cerebral palsy, or certain spinal cord injuries.

(3) If the flexible or spastic flatfoot is severe or has been present for many years, the joints of the foot become stiff in the flatfoot deformity. It is then known as *rigid flatfoot*.

b. Depressed Metatarsal Arch. The metatarsal arch is one of the transverse arches of the foot (para 23*c*). It can be described as a "cupping" of the sole of the foot, just as the palm of the hand is "cupped" from side to side. This arch runs across the foot in the area of the metatarsal heads. In the foot the weight of the body is distributed on three main points —the heel, the two sesamoid bones under the first metatarsal, and the fifth metatarsal head. When standing, the weight is borne chiefly by the heel and the ball of the great toe. The lateral border of the foot, the lateral metatarsal heads, and the toes provide balance. In the act of walking, the heel first receives the weight and then transfers it to the ball of the great toe. When the metatarsal arch is depressed, weight is borne chiefly on the second, third, and fourth heads, resulting in pain and callous formation. Women bear more weight on these heads than do men, because the higher the heel, the more weight is placed on the forefoot. Corns ultimately develop in these calluses.

c. High Arch. Pes cavus is a deformity characterized by a high longitudinal arch. Its cause is still unknown. Pes cavus falls into two categories, congenital and acquired. The disability to which this condition gives rise is due not only to the deformity itself but to the painful callosities which invariably form under the forefoot and the corns which appear over the clawed toes.

d. Metatarsalgia. Metatarsalgia is a painful condition of the fore part of the foot which may be due to pinching of the sensory nerve running between two adjacent metatarsal heads.

e. Painful Heels. Pain in the heel is a comparatively common and often troublesome complaint. It may be due to plantar fascia strain, calcaneal bursitis, or spur formation on the plantar surface of the heel bone.

f. Hallux Valgus. Hallux valgus (bunion) is more commonly found among women than men. It is a deviation of the great toe toward the outer or lateral side of the foot, and may be caused by wearing short pointed shoes or by structural abnormalities.

g. Hallus Rigidus. Hallus rigidus is characterized by degenerative arthritis, which causes stiffness of the metatarsophalangeal (MP)

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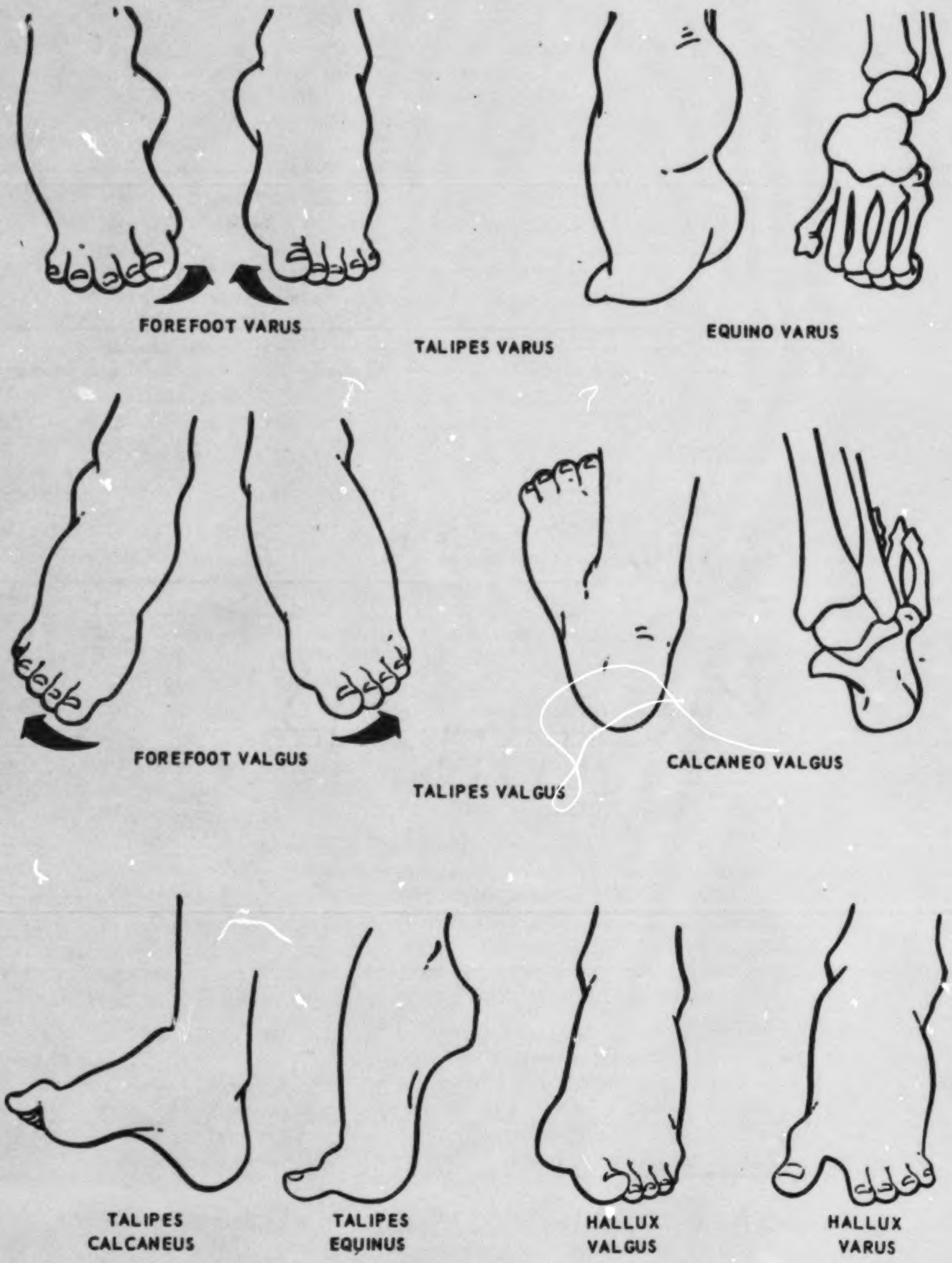
FOREFOOT VARUS
TALIPES VARUS
EQUINO VARUS
FOREFOOT VALGUS
TALIPES VALGUS
CALCANEO VALGUS
TALIPES CALCANEUS
TALIPES EQUINUS
HALLUX VALGUS
HALLUX VARUS

Figure 45. Common congenital foot abnormalities.

joint of the big toe. Because of stiffness in this joint, walking is painful.

h. Hammer Toe. This deformity consists of hyperextension of the metatarsophalangeal joint and flexion at the interphalangeal joints. Pain arises from the development of a corn over the top of the proximal interphalangeal (PIP) joint.

i. Plantar Warts. Plantar warts appear on the sole of the foot. They are probably infectious in origin and are very stubborn to treat.

CHAPTER 4

WOUNDS

58. General

A wound is a body injury caused by physical means with resulting disruption of the normal continuity of the tissue, organ, or bone affected. Wounds may be classified according to type, anatomical location, and causative agent.

a. Wounds may be generally classified as *closed* wounds or as *open* wounds. They may be *single* or they may be *multiple.*

b. Classification of wounds according to anatomical location includes head wounds (subdivided into skull, face, jaw, wounds); abdominal wounds; chest wounds; wounds of the limbs (arms and legs); wounds of the joints; and spinal and pelvic wounds. The part of the body most severely injured determines the subclassification of multiple wounds.

59. Closed Wounds

In closed wounds there is no break in the skin. The following are subclassifications of closed wounds:

a. A *contused wound* (CW), or contusion, is a subcutaneous injury, commonly called a *bruise,* caused by impact from a blunt object. In contusions there is little danger of infection, but swelling and black and blue discoloration may occur if blood leaks from the injured capillaries. When a larger blood vessel is broken, the blood may collect in a pocket in the tissues. This collection is called a *hematoma.*

b. A *dislocation* is the displacement of the normal relationship of the bones forming a joint.

c. A *sprain* is an overstretching or tearing of ligaments around a joint.

d. A *strain* is the stretching or tearing of a muscle or a tendon.

e. In a *closed fracture* the bone is broken without causing a break in the overlying skin.

f. Rupture occurs when a muscle or an internal organ bursts because of pressure from a hard blow or an explosion. There may be no injury to the skin or no external evidence of a wound.

60. Open Wounds

(fig. 46)

In open wounds the skin and underlying structures are cut, torn, or penetrated.

a. A *lacerated wound* (LW) is a wound that is irregular and torn, with jagged edges, such as wounds caused by bomb or high explosive shell fragments.

b. An *incised wound* (IW) is a cut made by a sharp object, such as a knife, a bayonet, or broken glass.

c. An *abrasion* is a wound in which outer layers of the skin have been scraped off or scratched. An abrasion results when a rough object is rubbed forcibly along the skin.

d. A *puncture wound* is one caused by a sharp and pointed object, such as a nail or an ice pick. Even though the wounding agent is withdrawn from the wound, it may carry bacteria deep into the tissues. This enables tetanus or other infection to develop in the wound.

e. A *penetrating wound* (Pen W) is one in which a foreign object enters the body and lodges there.

f. A *perforating wound* (Perf W) is a wound that goes through the body, the head, or a limb.

g. An *open fracture* is a break in the bone that communicates with the outside surface of the skin through a wound channel, or by protrusion of a bone fragment through the skin or mucous membrane.

61. Classification of Wounds by Causative Agents

Classification of wounds according to their causative agents is especially important in diagnosis and treatment. Among the most common agents are the following:

a. Bullet Wounds (fig. 46). Bullet wounds vary greatly in severity and form. Many bullet wounds, particularly those caused by the smaller caliber weapons or bullets which have nearly spent themselves, pass through the tissue, doing little harm, and leave an "ice pick" wound. The small wounds of entrance and exit, connected by a tract, are usually clean. Usually little damage is done unless the bullet hits a bone, vessel, or nerve. Often little or not treatment is necessary and recovery is rapid. Rifle bullets of large caliber or high velocity cause wounds of various types. Frequently the wound of entrance is small and the wound of exit large and lacerated, but sometimes the exit wound is smaller than the wound of entrance. The damage resulting from bullet wounds varies with the toughness and elasticity of the tissue.

(1) The skin is tough and elastic and frequently will stretch during the expansion of the tissue caused by the bullet and will be relatively uninjured.

(2) The muscle, however, is usually damaged greatly.

(3) The nerve tissue and blood vessels are tough and elastic and will hold together. Frequently, nerve and blood vessels survive intact even though surrounding muscle tissue is killed. In fact, many times an intact nerve or vessel is seen strung from one wall of a wound to the other.

(4) The bone is tough but brittle. The im-

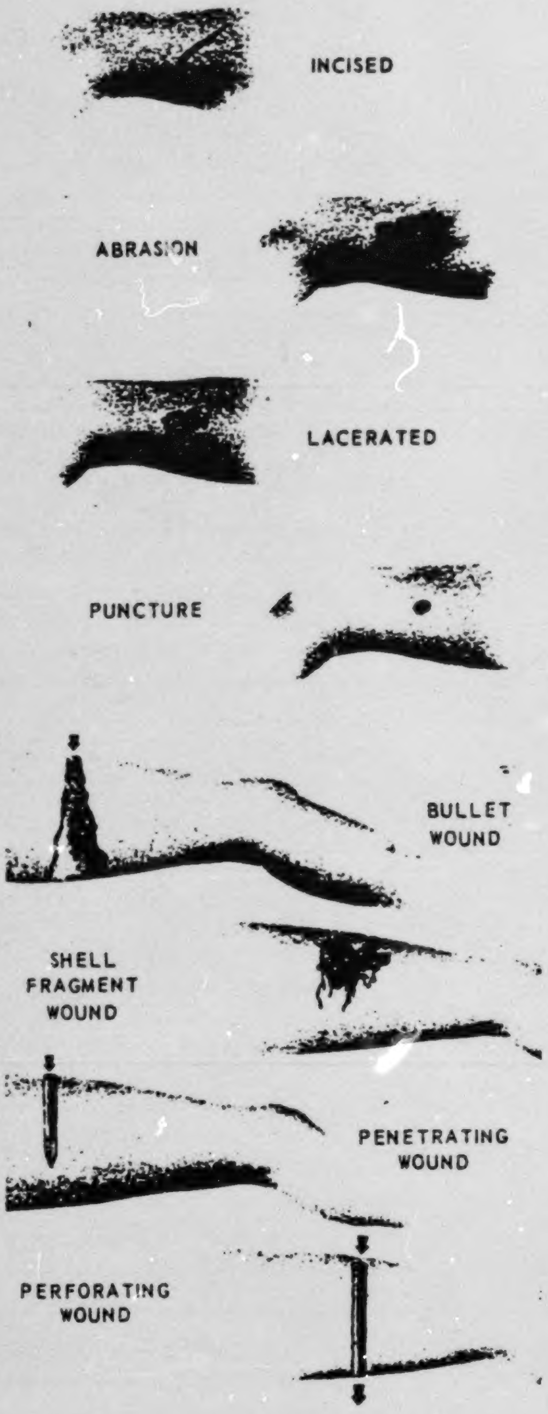

Figure 46. Types of wounds.

pact of a bullet suddenly entering the tissue, even though the bullet does not hit the bone directly, frequently causes it to crack.

(5) The damage to the abdomen varies with the types of organs that are hit. If the bullet passes through a solid organ, such as the liver, spleen, or stomach full of food, it has an explosive effect and tears large amounts of tissue. If the bullet does not encounter the liver or spleen, or if it perforates an empty stomach, it is likely to make the same sort of small holes in the organs as it makes at the wound of entrance in the skin.

b. Shell or Bomb Fragment Wounds. These wounds are caused by sharp, jagged pieces of steel of almost any size from that of the head of a pin to that of a man's hand. Generally they are large, irregular, lacerated wounds with much tissue damage. They often have no wound of exit.

c. Bayonet and Knife Wounds. Bayonet and knife wounds are usually incised wounds.

d. Burns. These wounds are caused by thermal (heat) agents, chemicals (such as acids and alkalies), electricity, and radioactive substances.

e. Concussion or Blast Injury Wounds. These wounds are due to sudden, terrific changes in pressure. Frequently no open wound results from this type of injury. The lungs may be injured, causing considerable edema and hemorrhage, the abdominal organs may be ruptured, or the nervous system may be injured.

f. Poisoned Wounds. These are wounds which are complicated by the presence of poison—for example, snake or poison insect bites. They are usually puncture wounds.

62. Inflammation

Inflammation is the local reaction of the body to irritation or injury. It occurs in tissue that is injured but not destroyed. It is a defensive and protective effort by the body to isolate and eliminate the injuring agent and to repair the injury. Inflammation plays an important and usually helpful role in the treatment of fractures, dislocations, sprains, open wounds, burns, frostbite, and infection.

a. Causes. Inflammation can be caused by any of the following types of injury agents:

(1) Traumatic, such as blows and mechanical irritation.

(2) Chemical, such as venom of snakes, mustard gas, acid, poison ivy, or stings of insects.

(3) Heat or cold.

(4) Pathogenic bacteria, such as staphylococcus and streptococcus.

(5) Other agents, such as electricity, X-ray, and rays of the sun.

b. Signs and symptoms. The signs and symptoms of inflammation are redness, heat, swelling, pain, and disturbance of function. They are caused by the reaction of blood vessels and tissue in the injured area.

(1) When injury occurs, the blood vessels dilate, thus increasing the supply of blood to the injured area. The blood is warm and red, producing the first two signs, *redness* and *heat.*

(2) As the blood vessels dilate, their walls leak and blood serum escapes into the tissues. This results in *swelling.*

(3) Pressure of the swelling on nerve endings causes *pain.*

(4) *Disturbance of function* can result from the pain or from interference by the swelling.

c. Basic Reactions. The dilation of blood vessels and the mobilization of white cells against the injuring agent are the two basic reactions in the inflammatory process. While changes in blood vessels are producing the signs and symptoms of inflammation, the body is reacting to the injury in another way. White cells leave the dilated blood vessels and move through the tissue fluids to the site of the injury (fig. 47) The cells make a wall around the area to seal off the injurious agent. Within this area the white cells work as scavengers (phagocytes)

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and ingest small particles of foreign matter, dead tissues, or bacteria if present. As the source of injury is overcome or expelled, tissues return to normal. White cells disperse. Blood vessels return to normal size. Fluids flow away through the lymphatics. If tissue has been destroyed it is replaced by scar tissue.

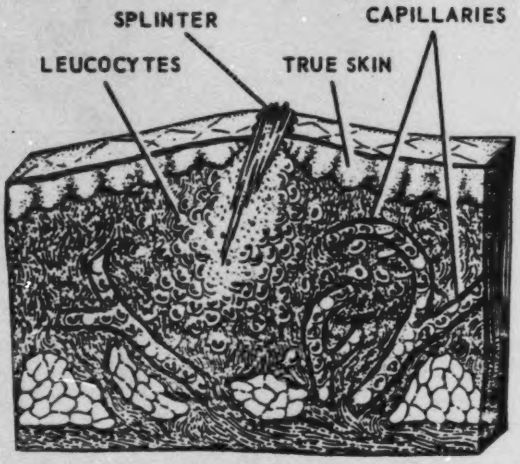

Figure 47. Tissue changes in inflammation.

63. Septic Inflammation

Pathogenic (disease producing) bacteria exist on the skin, in the mouth, and on everything that has not been sterilized. Normally, the intact skin and mucous membranes keep bacteria from entering the body. When there is a break in the skin or the mucous membranes are irritated, bacteria may enter the body and invade the tissues. Usually the white cells and blood fluids from dilated capillaries can localize and destroy the invading organisms. The principal danger in inflammation occurs when body defenses fail to overcome the invading pathogenic bacteria. If this happens the bacteria and their associated poisons enter the bloodstream, spread throughout the body, and produce a condition called *septicemia*, or septic infection.

64. Abscess Formation

a. In the process of inflammation, white blood cells move into the tissues and form a wall about the injured area. These cells also attack bacteria inside the walled area. Tissue, bacteria, and cells destroyed in the struggle mix with tissue fluids to form the liquid matter called *pus*. This walled-in collection of pus is called an abscess.

b. The most common types of abscesses are furuncles (boils) and carbuncles. A furuncle is an abscess in which the collection of pus lies within the tissue below the true skin. A carbuncle is an infection in which there are several abscess cavities often growing together to form one large abscess beneath the skin.

c. Abscesses occur most commonly in the skin, but they may develop in any part of the body—in the bones, brain, kidneys, liver, muscles, lungs, or in spaces between organs. An abscess, if not relieved by surgical incision and drainage, may find its way to the surface, open spontaneously, and drain.

65. Healing

Healing is a process related to inflammation, for both are started by tissue injury. It would be ideal if the body could heal itself by replacing all damaged tissues with an exact counterpart. Thus, an eye would be replaced with a new eye and a tooth with a new tooth. But very few tissues are replaced in kind. Examples of tissues which may replace themselves are liver tissue, kidney tubules, and connective tissue. Bone, which is one kind of connective tissue, may replace itself if broken; that is, the broken bone is repaired by the formation of new bony tissue. Healing in most tissues, however, is a process of replacement; the destroyed tissue is replaced by scar tissue (fibrous type of connective tissue). If brain cells are destroyed, they are replaced by connective tissue. If the heart muscle is injured, the damaged fibers are replaced by connective tissue. When a tooth is pulled or an eye is lost, the sockets are filled with connective tissue. Hence, replacement by scar tissue is the usual order in healing. In wound healing this may happen by primary intention or by secondary intention.

a. Primary Intention. A clean wound is closed by suturing, so that its walls are pressed against each other. Fiber-forming cells carry fibers from one wall to another, binding them together. When the process is completed, the walls are held and healed by a thin scar of fibrous connective tissue. If the skin has been involved, epithelium grows out from the cut edges of the skin to cover the scar (fig. 48).

b. Secondary Intention. When a wound is left open, healing takes place by the filling of the cavity from the bottom up to the surface. On the walls and base of the wound a tissue composed of capillaries and fiber cells forms. This is called granulation tissue. It gradually fills the wound, crowding out all foreign matter, and is finally covered by epithelium growing in from the cut edges of the skin (fig. 49).

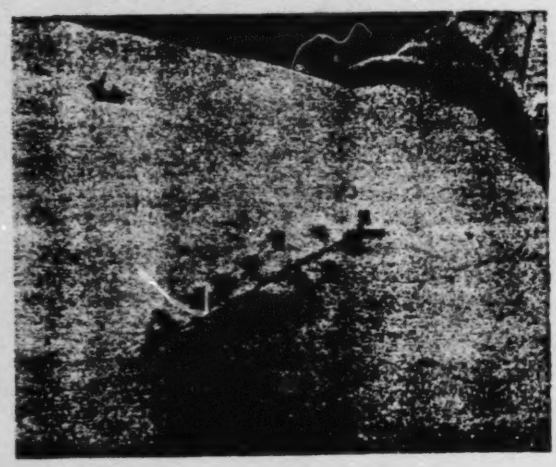

Figure 48. Wound healed by primary intention.

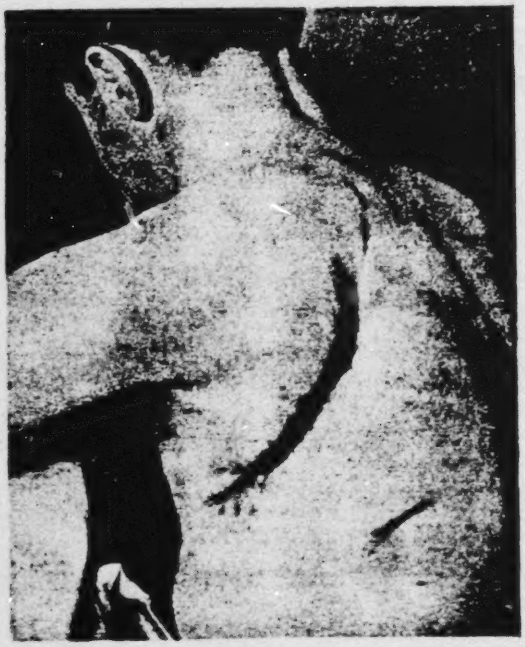

Figure 49. Wound healed by secondary intention.

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CHAPTER 5

SURGERY

66. General

The American Board of Orthopedic Surgery defines orthopedics as the medical specialty that includes the investigation, preservation, restoration, and development of the form and function of the limbs, spine, and associated structures by medical, surgical, and physical means.

67. Types of Amputations

There are various types of amputations of both the lower and the upper limbs. Some types lend themselves better to the fitting and function of a prosthesis than do others. Sound consideration and judgment should be given by the surgeon at all times as to the site and method of amputation, both of which can be determined by circumstances and the condition of the limb. The optimum site for amputation under given circumstances should be determined with the idea in mind of enabling the patient to be fitted with the best functional prosthesis for his needs.

a. Shoulder Disarticulation. The shoulder disarticulation, which is an amputation through the shoulder joint, should be avoided whenever possible, since it is extremely difficult to provide a good functional prosthesis for this type of amputation. Usually the greatest advantage derived from the prosthetic appliance for shoulder disarticulation is that of cosmetic appearance.

b. Above-Elbow Amputation. The patient with an above-elbow amputation can be fitted with a fairly good functional prosthesis, provided the stump is not too short. The ideal length for above-elbow stumps is 7 to 8 inches, which allows an internal joint in the prosthesis; however, no length should be sacrificed for this purpose.

c. Elbow Disarticulation. Elbow disarticulation amputations make excellent stumps and patients who have them should be encouraged to develop maximum use of them. The bulbous end and flare of the condyles add to the stability of the prosthesis. External joints are now available to make a good prosthesis.

d. Below-Elbow Amputation. The below-elbow amputation offers possibilities for good functional restoration. There is no ideal length, since all length possible should be saved and fitted. The longer the stump, the greater the amount of pronation and supination that can be restored in the prosthesis. If the stump is any shorter than 3 inches, full flexion of the prosthesis is restricted; and in order to adequately obtain maximum flexion of the prosthesis it sometimes becomes necessary to fit the patient with a double-action type of elbow joint.

e. Wrist Disarticulation. The wrist disarticulation is recommended as a useful stump, which in most cases retains full forearm rotation. It is the best forearm amputation for restoration of function.

f. Partial-Hand Amputation. Partial-hand amputations are desirable if one or more of the digits can be retained for opposition with the thumb or an artificial finger; however, partial-hand prostheses are difficult to make with maximum functioning ability, and in some instances the partial-hand amputee is more comfortable and can do more without a prosthesis. The partial-hand prosthesis would have its greatest value in cosmetic appearance.

g. Hip Disarticulation. In the lower limb amputations, the hip disarticulation is not desirable and should be avoided if possible, since it necessitates the fitting of a heavy and bulky type of prosthesis with multiple joints.

h. Above-Knee Amputation. Above-knee amputations are performed through the shaft of the femur. The ideal length for above-knee stumps is 10 to 11 inches, measuring from the tip of the trochanter. This length will allow necessary room for the fitting of the knee joint mechanism on the prosthesis and still give maximum functional control. The above-knee stump should not be shorter than 8 inches if it can be avoided. A stump any shorter than this gives the amputee patient poorer functional control over his prosthesis.

(1) An amputation just above the femoral condyle is the best above-knee amputation, because the stump can be fitted with a partial end-bearing prosthesis.

(2) The supracondylar tendoplastic amputation is a popular amputation for fitting with an end-bearing prosthesis. The patella is removed, and the quadriceps tendon is used to cover the end of the femur.

i. Knee Disarticulation. Disarticulation at the knee joint is a less well-recommended procedure, although the condyles of the femur are left in place, giving a greater weight-bearing surface. The stump end is bulbous, which makes it difficult to fit from a prosthetic standpoint; but when the prosthesis is well fitted it can be used for hours without too much discomfort.

j. Below-Knee Amputation.

(1) The ideal length of a below-knee stump for a patient of average size is approximately 6 inches, measuring from the articular surface of the tibia. A stump of 3 inches can be fitted with a good functional prosthesis; however, a stump any shorter than this does not seem to have sufficient leverage to enable the amputee to adequately flex and extend the prosthesis while he is walking. A short below-knee stump has a tendency to pop out over the anterior part of the socket while the amputee is walking. An extremely short below-knee stump can be fitted with a bent-knee prosthesis, which is an end-bearing appliance in which the weight is carried on the stump with the knee flexed to right angles.

(2) The Syme amputation stump is made by fashioning and fitting the heel pad to the distal end of the tibia and fibula at the ankle joint. This end-bearing stump requires a rather bulky type of prosthesis, but has the additional advantage of enabling the amputee to walk short distances on the stump without a prosthesis.

k. Partial-Foot Amputation. The Chopart amputation is a disarticulation through the midtarsal joints. This type of amputation is undesirable from a prosthetic standpoint, since a good functional prosthesis is difficult to construct. Furthermore, the foot soon goes into an equinus deformity. The Lisfranc amputation, a disarticulation through the tarsometatarsal joints, is undesirable for the same reasons. Partial-foot amputations through any point distal to the bases of the metatarsals are superior to any other lower limb amputation. If the great toe can be saved the gait is practically normal.

68. Arthrodesis

Arthrodesis is the surgical fixation of a joint by fusion of the joint surfaces. The purpose of arthrodesis is to fix or stop the motion of a joint in which there is deformity or arthritic change resulting from injury or wear and tear. It is usually performed to stop pain in the joint. Occasionally it may be done for extremely unstable joints or nonfunctioning joints, particularly in the fingers. This procedure may involve the use of bone grafting, using bone from the ilium of the patient, or possibly tibial bone if rigidity is needed. Following the surgery, many patients have repeated cast changes while the joint is becoming solid. Some of them receive temporary braces after the case is removed.

69. Arthroplasty

Arthroplasty, or plastic surgery of a joint, may be described as "plastic repair" of a joint. The purpose of this procedure is to improve the function of a joint. Arthroplasty may involve actual smoothing of the joint surface, repair of ligaments which stablize the joint, or removal of arthritic overgrowths from the joint. It may include removal of all or part of the joint and substitution of a metal or plastic replacement for it. Probably the most common form of arthroplasty is the one which is performed to repair the ligaments and muscles around the shoulder joint which chronically dislocates. Removal of the head or proximal end of the femur and substitution of a metallic prosthesis shaped like the head of the femur is another form of this operation (fig. 50).

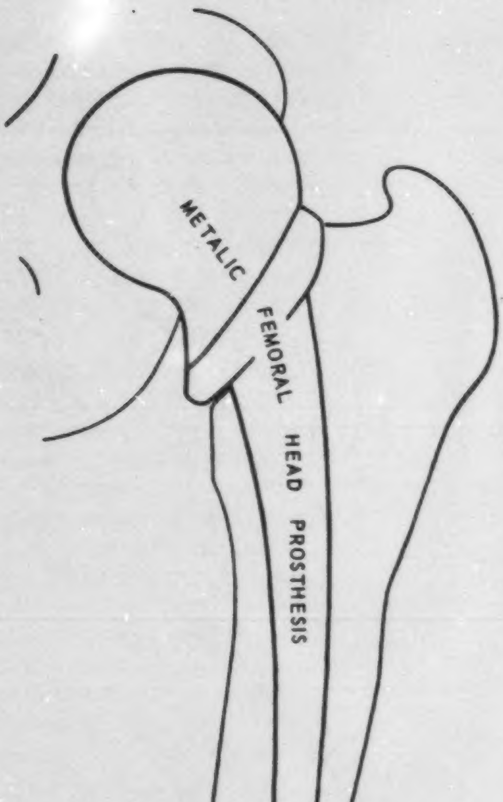

Figure 50. Patient's hip with prosthesis in place.

70. Arthrotomy

Any operation which requires the joint to be opened and entered is called an arthrotomy. The specific procedures after the joint has been entered may change the naming of this procedure, since they will describe specifically what is to be done inside the joint. Some specific types of arthrotomy are for arthrodesis, arthroplasty, and meniscectomy. Meniscectomy, the operation for removal of the meniscus (fig. 24) from the knee joint, is probably the commonest arthrotomy done on the Orthopedic Service.

71. Biopsy

When a patient has a tumor of a bone, all or part of that tumor must be removed by surgery, so that it can be examined under the microscope to determine whether it is benign or malignant. After the tumor or part of it has been removed and examined, the decision is made to remove it locally or to radically remove it up to and including amputation. Biopsy may weaken the bone sufficiently to require external support, and the orthopedic specialist may be called upon for help in the application of plaster in the operating room.

72. Bone Grafting

Transfer of bone in the human body is performed to replace or reinforce areas where fractures are healing slowly or where large amounts of bone have been lost or removed. It may also be used to strengthen arthrodeses. The common sources of bone used for grafting in the human are the iliac bones and the tibia. This bone may be classified as follows:

a. Autogenous Bone. Autogenous bone is bone taken from the patient himself and transplanted, usually at the same operation, to the site to be repaired.

b. Homogenous Bone. Occasionally it happens that for reasons of age or physical condition of the patient, autogenous bone cannot be taken. Homogenous bone is then used. This bone is obtained from various human sources and stored in a "bone bank" until needed. The bone may be preserved by various forms of freezing or by the use of chemicals until needed, and offers the surgeon the advantage of readily available bone at any time.

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73. Neurorrhaphy

When a nerve has been divided, it is necessary to reconnect the severed ends. This is most commonly done by suturing. The procedure is called neurorrhaphy. Neurorrhaphies are performed at the time of the injury in patients with clean uncontaminated combat wounds. Since a part of the nerve is usually sacrificed to get a fresh nerve end for more rapid and complete healing, it is necessary to flex joints to shorten the distance the nerve has to travel to span the gap. These joints are maintained in flexion after the operation by the use of casts applied in surgery. After the casts are removed, the joints are usually supported by bracing to prevent contractures. The orthopedic specialist may become quite familiar with assisting in the care of these patients.

74. Osteotomy

Osteotomy is the division or "breaking" of a long bone by surgical incision. The purpose of osteotomy is to correct some deformity which may have occurred during the growth of a patient or during the healing of a fracture. Since this is similar to producing a new fracture, both internal and external fixation of the new fracture may be required. The orthopedic specialist will assist in the cast changes related to this operative procedure.

75. Open Reduction

In open reduction, a surgical opening is made to expose the fracture and the bone ends are stabilized by internal fixation.

76. Closed Reduction

In closed reduction, the fracture is realined to normal position without opening the skin. This may be done by manual traction or manipulation, traction apparatus, or a combination of both. Closed reduction is accomplished under X-ray control to be certain that the fracture is in correct position, usually before the plaster is applied and again after the plaster is set.

77. Internal Fixation

(fig. 51)

Internal fixation includes all forms of bone stabilization operations usually performed for fractures, in which the stabilizing material is actually attached to the bone itself or placed within it.

a. Some types of internal fixation are the following:

(1) *Screws*. Stainless steel screws can be inserted across spiral fractures and hold the fracture together much as a carpenter joins two rods or poles. This method is of little use, however, if the two surfaces to be joined do not overlap a reasonable distance to allow strength.

(2) *Plates*. Stainless steel plates are long, flat, and thin, similar to the flat sticks on which ice cream bars are mounted. This type of plate has multiple holes down its length which allow the plate to be attached, by means of screws, to the surface of the bone to provide stability and strength to the fracture while it is healing. There are many types of plates, usually named after the surgeons who perfected them.

(3) *Nails*. The nails used in internal fixation are called intramedullary nails, a name derived from the fact that they are intended to be inserted down the medullary or marrow cavity of the bone. They are made of stainless steel, and they may be solid or hollow. The length of these nails is nearly equal to that of the bone in which they are inserted. They bear little or no resemblance to the nails used in carpentry in that they may be contoured to fit the bone, are much longer, and do not have a flat head.

(4) *Wire*. Stainless steel wire may be used to wire the ends of the bone in contact or to hold two bones together. This method of internal fixation depends heavily on external support (as from a cast) for stability, since the wire adds little rigidity to the fracture site. For this reason, the orthopedic specialist who assists in patient

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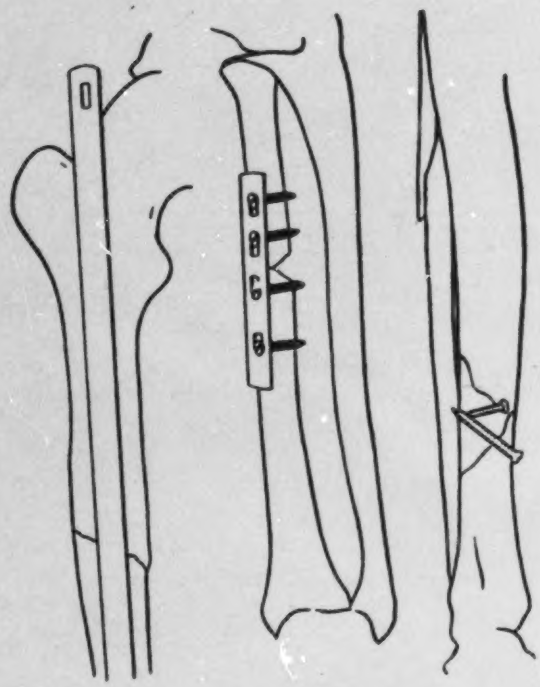
care following this procedure must exercise extreme care in handling the body part when it is out of the cast.

(5) *Glue.* Recent experiments with plastic products and some natural products derived from blood have led to the hope that some form of glue will be devised which can be molded in the bone and will set or harden. No satisfactory form has yet been accepted.



A. KUNSCHER INTRAMEDULLARY NAIL

B. SLOTTED PLATE FOR BONE FIXATION

C. SEVERAL BONE SCREWS

Figure 51. Types of internal fixation.

b. Since surgery is required to expose the bone for the placement of internal fixation devices, the surgeon weighs carefully the hazards of the operation against its advantages. All forms of internal fixation depend upon metal strength to hold while the bone heals, and metal is subject to fatigue and breakage. For this reason the orthopedic specialist must not be deceived by the apparent solidity of the fracture soon after an operation, and must avoid careless and rough handling at all times.

78. Skin Grafting

In preparing for orthopedic surgery, it is often necessary to transfer skin from one part of the body to another to obtain closure of wound or good tissue. This transfer of skin is called skin grafting. It may take many forms, some of which are the following:

a. Pinch Graft. In this type of skin grafting, the surgeon takes numerous very thin small "dots" of skin and plants them in the area to be covered, where they attach themselves and spread, gradually covering the area which was previously bare of skin. This technique is seldom used.

b. Split Thickness Graft (fig. 52). As the name implies, this graft involves a split thickness of skin. A split thickness of a section of skin is taken and moved to another site. The part of the skin thickness which remains in the donor site grows a new covering for that area, and the transferred piece of skin provides growing cover for the previously bare area. This skin is in the form of sheets taken with an instrument called a Dermatone.

c. Pedicle Skin Graft (fig. 53). In a pedicle graft, the entire thickness of the skin and some of the subcutaneous tissue are taken. This graft is too thick to be detached from its blood supply and survive, so it is transferred by a number of operations which attach it to the place where it is going to be growing before it is completely cut free from the site of origin. Since this method of skin grafting takes the full thickness of the skin, it is necessary to repair the donor site by the use of a split thickness graft from elsewhere on the patient. Full thickness skin grafting of this type gives the best skin coverage, since it transfers the full thickness of living skin and makes subsequent surgery much safer and easier.

79. Tenodesis

When a patient has a nonfunctioning muscle

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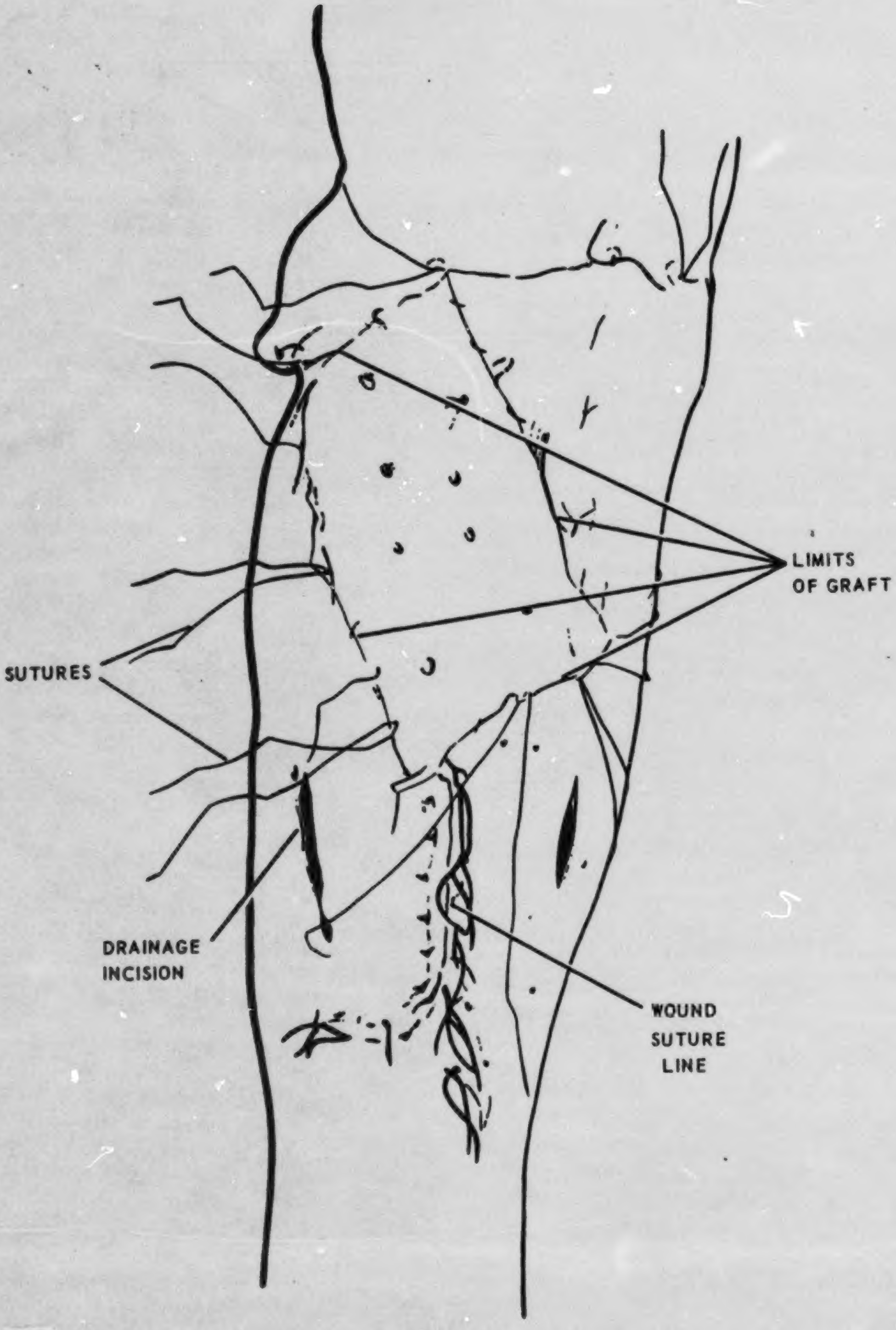
SUTURES
LIMITS OF GRAFT
DRAINAGE INCISION
WOUND SUTURE LINE

Figure 52. Split thickness skin graft.

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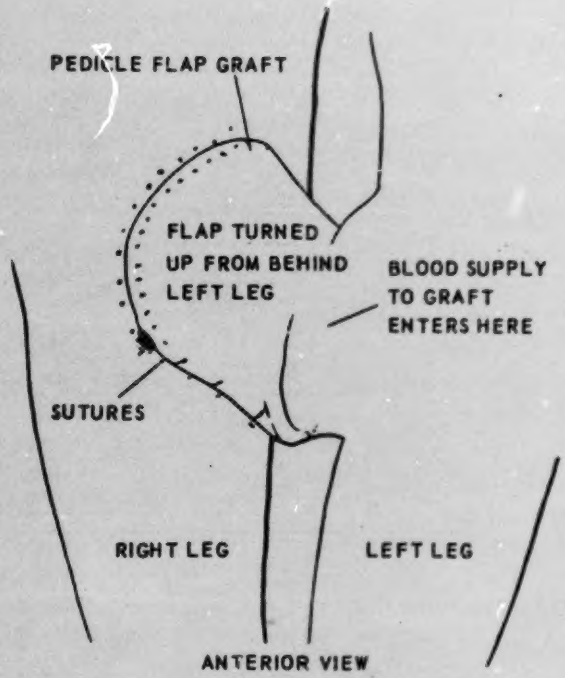
PEDICLE FLAP GRAFT
FLAP TURNED UP FROM BEHIND LEFT LEG
BLOOD SUPPLY TO GRAFT ENTERS HERE
SUTURES
RIGHT LEG
LEFT LEG
ANTERIOR VIEW

Figure 53. Pedicle skin graft.

due to paralysis of that muscle from loss of nerve supply or local muscle destruction, the improvement that can be made in function by dividing the tendons from their muscles and causing them to adhere to bone is often very encouraging. This operation in which the tendon is divided and attached to the underlying bone is called tenodesis. An example of a patient on whom tenodesis may be performed is the one who has median nerve paralysis and also cannot extend or straighten his fingers. It is possible to attach the finger extensor tendons to the dorsal surface of the radius in such a manner that, when the wrist is allowed to fall by gravity, the adherent tendons pull the fingers into extension allowing the hand to open. This operation is not used as often as formerly, since the transfer of an active muscle to operate the one with loss of function is a preferred procedure if this transfer is possible.

80. Tenorrhaphy

Tenorrhaphy is the surgical repair of tendons which have been severed by injury or have ruptured spontaneously. The tendon ends are sutured together, and after the operation the part is immobilized in plaster for approximately 3 weeks to allow the tendon ends to heal.

81. Tendon Transfer

It is possible to substitute for a permanently paralyzed or badly damaged muscle by transferring a less necessary muscle and attaching it to the tendon of the paralyzed muscle. This transfer is done by rerouting the muscle but leaving it still attached to its usual origin and not disturbing its nerve and blood supply. Following a period in plaster to protect the newly sutured tendon, the patient will require extensive reeducation in the use of his muscle in its new functional role.

82. Wound Closure

In the military service the decision to close wounds or to leave them open without suturing is often dependent upon the circumstances of wounding, as well as the condition of the patient. The following descriptive terminology will help to explain the stages of wound closure and the meaning of them.

a. Primary Closure. Primary closure is the procedure of suturing the patient's wound at the time he is first seen in a facility equipped for this operation. It should not be used for wounds or injuries received in circumstances which are dirty, such as in combat, when dirt has been ground into the wound, or when more than 6 hours have passed since the wound was incurred.

b. Delayed Primary Closure. Delayed primary closure is more acceptable in the field. In this type of operation, the wound is cleaned and debrided, as is done for all wounds, but the wound is left open without the use of sutures. This open wound keeps on its surface infection which develops. Between 3 and 7 days following the initial debridement, the wound is cleaned and debrided, and sutured.

c. Secondary Closure. Secondary closure is the resuturing of a wound. It may be performed when wounds have opened because of early suture removal, poor nutrition, or when they have been intentionally opened again.

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CHAPTER 6

ASEPSIS AND STERILIZATION

83. General

Infection is caused by pathogenic (disease producing) microorganisms. After the microorganisms enter the body, they produce infection either by their multiplication or by formation of toxins (poisonous waste products). These toxins may destroy tissue, dissolve blood cells, or produce a general toxic reaction in the body. If they get into the bloodstream they are spread throughout the body, producing a poisoning called *sepsis*. The prevention of sepsis by the destruction of microorganisms or by preventing and checking their growth and multiplication is called *antisepsis*.

84. Classification of Pathogenic Organisms

Pathogenic microorganisms may be classified as follows:

a. Bacteria. Bacteria are minute, one-celled organisms so small they can be seen only through a microscope. Bacteria may occur alone or in large groups called colonies. Each bacterium is independent and may live and reproduce by itself.

b. Viruses. Viruses are protein bodies which are smaller than bacteria. They can multiply only in the presence of living cells. They cause measles, mumps, influenza, and certain other illnesses.

c. Fungi. Fungi are simple plant organisms which are larger than bacteria. They most often attack the skin. They cause such infections as ringworm and athlete's foot.

d. Worms. A few kinds of worms can live inside the human body and cause disease. Examples are hookworm, and pork tapeworm.

e. Protozoa. Protozoa are one-celled animals, a few of which cause illness in man. One of the most important diseases caused by protozoa is malaria.

85. Distribution of Bacteria

There are many possible sources of infection, since bacteria are always present in air, water, and food and on manmade objects.

a. Contamination may come from dust floating in the air or from droplets discharged from mouths and noses of people as they breathe.

b. Bacteria flourish in moist surroundings at temperatures near that of the human body. Under less favorable conditions they may continue to exist, without multiplying, for a long time. All but spore-forming bacteria are usually destroyed by sunlight or by drying.

c. Certain varieties of bacteria, such as staphylococci and streptococci, are found on normally clean skin. Any wound of the skin surface, therefore, may be contaminated.

d. The mouth, tonsils, and throat harbor many types of bacteria, particularly streptococci. The intestinal tract, especially the colon, contains many bacteria, notably the coliform bacillus group and streptococci.

e. Well-manured farmland harbors the anaerobic bacilli of tetanus and gas gangrene.

86. The Body's Defenses Against Bacteria

The healthy body has four lines of defense which have a remarkable ability to fight off bacteria and to withstand their effects; however, factors, such as injury, chilling, exposure, fatigue, and malnutrition, lower these defenses. Most of these factors are usually present in battle casualties.

a. The *first line of defense* protects the body's surfaces. The skin acts as a wall to keep out most bacteria. Bacteria that enter the nose and mouth find another barrier. It is the mucous membrane that lines the respiratory and digestive systems. Cells of the membrane secrete mucus which entangles bacteria. Some cells of the membrane have cilia which sweep bacteria out of the body.

b. The *second line of defense* is formed by the white blood cells, or phagocytes. They engulf and destroy bacteria that pass through the first line of defense.

c. The *third line of defense is immunity.* Previous encounters of the body with bacteria will produce a specific resistance or immunity to those particular organisms. This acquired immunity is associated with the formation of antibodies by the body. These antibodies interfere with bacterial invasion in several ways. They may neutralize bacterial toxins, may kill the bacteria, may make the bacteria more susceptible to attack by white blood cells, or may cause the bacteria to clot into little clumps which the white blood cells can destroy easily.

d. The *fourth line of defense* is the lymphatic system. Lymph cleans tissues, and then flows through vessels into lymph nodes. The nodes act as filters for removal of bacteria.

87. Wound Contamination and Infection

a. Contaminated Wounds. Contamination is the initial implanting of bacteria in a wound. All wounds, except those produced under aseptic conditions, are contaminated, for bacteria are universally present; therefore, all wounds are assumed to be contaminated when they come to the attention of medical service personnel. A heavily contaminated wound is apt to be complicated by a severe infection.

b. Aseptic Wounds. The only wounds not considered contaminated are those made in an operating room under sterile (aseptic) conditions.

c. Infected Wounds. In an open wound there is always danger of infection. In addition to bacteria, an open wound may contain dirt, pieces of clothing, bone fragments, and other foreign matter that favor infection. Closed fractures of the pelvic bones are also considered potentially infective, because bony splinters may penetrate the intestine, allowing coliform bacteria to enter other body tissues.

(1) If undisturbed for the first 6 to 8 hours, a contaminated wound shows little change. After that period of time the bacteria begin to multiply, invade the tissue beneath the wound, and give off toxins. Within 24 hours an obvious infection may be present. Then the wound is called an *infected wound.* Usually the body's resistance is great enough to isolate the infectious process, and the wound will heal by secondary intention (fig. 49), slowly filling in from the bottom and sides.

(2) If the infectious process cannot be isolated by the body, it extends locally through the muscles and along muscle and tendon sheaths. It extends through the lymphatic vessels, perhaps through the lymph nodes, and so into the general circulation. The spread of infection is accompanied by a severe, generalized toxic reaction, and the patient is extremely ill.

d. Signs and Symtoms of Infection. Evidence of infection is manifested in several ways, such as discoloration of the area and heat, redness, swelling, pain, and sensitivity around the wound or area. Other signs and symptoms include the formation of pus, red streaks radiating from the wound, and fever, headache, and malaise (vague feeling of bodily discomfort). There may be swelling or tenderness of the glands in the neck if the infection is in the head, in the armpit if it is in the arm, and in the groin if it is in the leg.

e. Measures to Prevent or Reduce Wound Infection. Some basic measures to prevent or reduce wound infection are the following:

(1) Open wounds are covered with dry sterile dressings.

(2) Minor cuts, bruises, and animal bites are washed with soap and water.

(3) An antiseptic is used to swab around minor wounds, but is *never put into an open wound.*

(4) Further injury, chilling, exposure, fatigue, or other factors that lower the body's resistance should be avoided.

(5) Antibiotics and tetanus toxoid are administered as ordered.

(6) Only sterilized surgical instruments and supplies are used.

88. Sterilization, General

Sterilization is the complete destruction of microorganisms. The methods of sterilization are physical and chemical.

a. Physical Agent Used in Sterilization. The physical agent used in sterilization is high temperatures. Bacteria can be killed by exposures to low and high temperatures. Resistance of bactria to extremes of temperature depends upon the species of microorganisms, the growth stage, and whether or not the microorganisms contain endospores. Spores have a much greater resistance to high and low temperatures than do vegetative forms. This high resistance in spores probably is due to the concentrated, dehydrated state of the protoplasm they contain. Bacteria in a dry state withstand high temperatures longer than do bacteria in a moist state. Low temperatures are much less destructive than are high temperatures. Heat may be used in various forms for sterilization. Moist heat may be applied as boiling water or as steam. Boiling water is used in the small instrument shown in figure 54. Steam under pressure is used in the dressing and utensil sterilizer, or field autoclave, shown in figure 55. Needles and similar metallic objects can also be sterilized by being held in an open flame, such as the flame of an alcohol burner.

b. Chemical Agents Used in Sterilization. A disinfectant is a chemical agent used to destroy bacteria or other organisms by a chemical reaction. The reaction is subject to the individual peculiarities of the bacteria and to the influence exerted by the physical forces upon both components of the reaction—the chemical agent and the bacteria. Different chemical agents act upon bacteria in different ways, stopping their growth or killing them by oxidation, coagulation, or other means.

89. Methods to Assure Absence of Microorganisms

a. Chemicals. Chemicals are frequently used to destroy bacteria on articles which cannot be subjected to heat. This method, however, is properly termed "disinfection." The efficiency of this method depends upon three factors: the concentration of the chemical, the type of material being disinfected, and the length of time the article remains in contact with the chemical solution. In general the following procedures apply:

(1) Use a sterile, covered container.

(2) Make sure that the article to be disinfected is clean and dry.

(3) Completely submerge the article in the solution.

(4) Soak the article for at least 30 minutes.

(5) Follow hospital procedure in the use of chemicals.

b. Heat. Sterilization by heat is the accepted method for all materials, except those damaged by this process.

(1) *Dry heat.* Some surgical supplies, such as petrolatum, gauze strips covered with petrolatum, oil of various

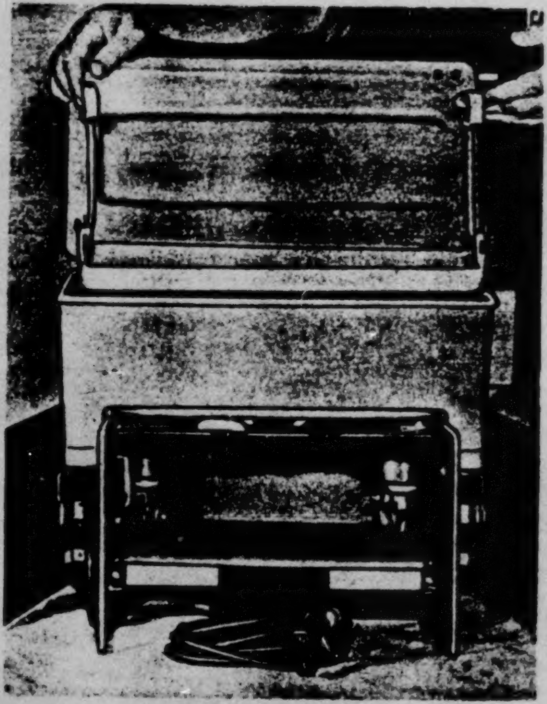

Figure 54. Instrument sterilizer, boiling type.

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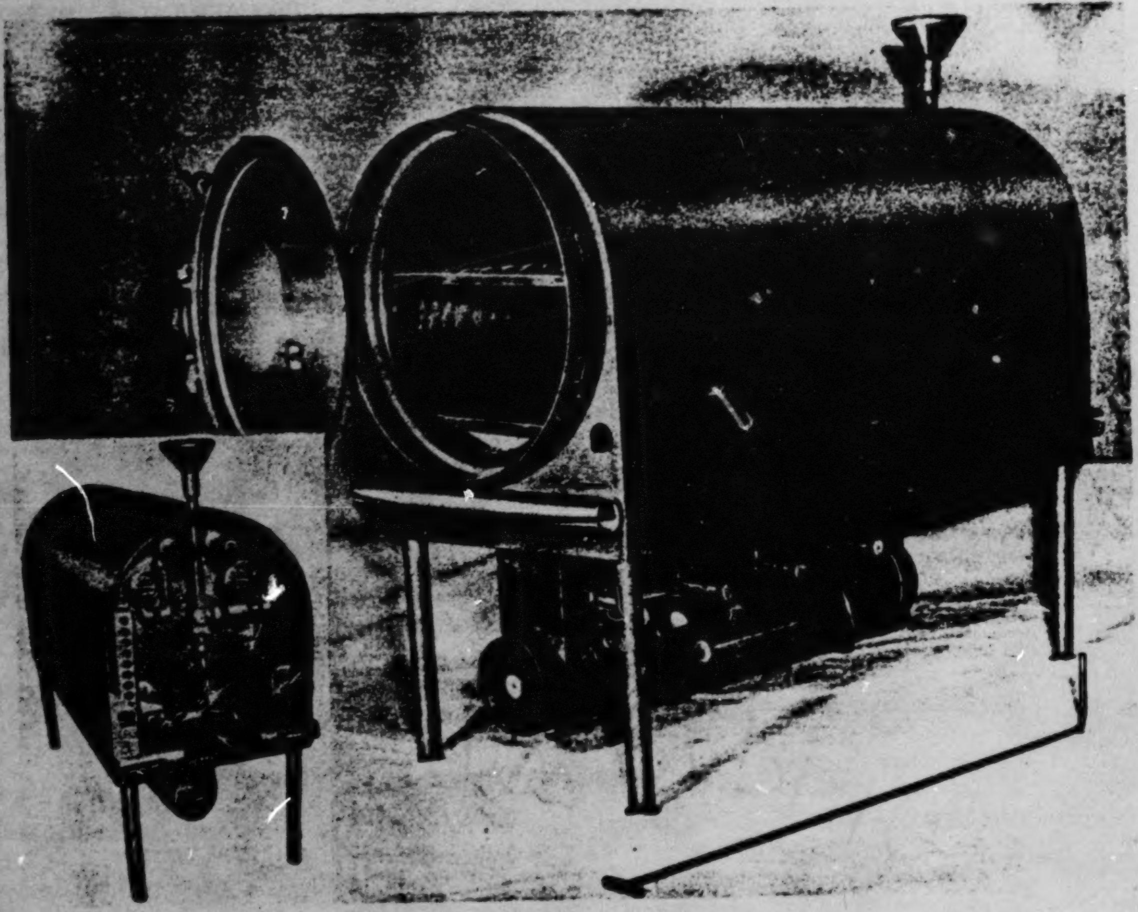

Figure 55. Field autoclave.

kinds, bone wax, and talcum powder, may be disinfected by dry heat. These substances are exposed to circulating hot air for prolonged periods in ovens which read 350 degrees F. Hot air sterilization is often used also for syringes, needles, and laboratory glassware.

(2) *Moist heat.* Moist heat is used to sterilize most articles.

(a) *Boiling.* Boiling is actually classified as disinfection, rather than sterilization. It should be used only when no autoclave is available. Boiling destroys most living microorganisms in a few minutes but does not guarantee the destruction of all spores, some of which (like those of tetanus or gas gangrene) resist many hours of boiling. The addition of sodium carbonate (3 to 4 teaspoons to a quart of water) adds to the effectiveness of boiling water against spores. If the article is clean, boiling it in this solution for 30 minutes will kill living microorganisms and some spores. *The article must be completely immersed.*

(b) *Steam under pressure.* The autoclave, which provides steam under pressure, is the safest and most frequently used method of sterilizing hospital supplies. An autoclave is so built that steam enters the sterilizing chamber under pressure for the purpose of reaching high temperatures. The steam of the autoclave at high temperatures destroys all bacteria and spores. Autoclaving is the method of choice for sterilizing most surgical supplies. (Instructions for assembly and operation of the field autoclave are contained in a booklet that comes with it.) There are many types of autoclaves, and improvements are constantly being made upon them. The principles of operating an autoclave should be learned and this knowledge adapted to the type of equipment used. Directions should be read carefully and hospital procedures followed regarding length of sterilization of various types of material.

90. Preparation of Supplies for Sterilization

a. General Rules. All articles to be sterilized must be clean and in good condition. Special methods are used in the cleaning and preparation of materials for sterilization, and frequently supplies and instruments are sterilized in packs. Different types of supplies require different types of sterilization and different handling. The basic principles should be learned and this knowledge adapted to the standing operating procedure of the hospital.

b. Wrapping Procedure. Articles to be sterilized are usually wrapped with muslin wrappers, in double thicknesses, large enough to cover the contents completely. The following steps should be taken:

(1) The wrapper is placed on the table in a diamond shape with one point toward the specialist.

(2) The item is centered on the wrapper.

(3) Next, the corner nearest the specialist is folded over. Then the right and left corners and finally the corner opposite the specialist are folded over. The tips of the corners are always turned back, so that the pack, after sterilization, may be unwrapped without touching the inside of the contents of the pack. A firm, compactly wrapped package should be the result.

(4) A Diack control (*c* below) is placed in the package, the package labeled, and secured with a string or pressure sensitive tape. Pressure sensitive tape has light marks on it which turn dark when the tape is subjected to heat under pressure. It furnishes another way to confirm the fact that the item has been sterilized. The largest pack for the autoclave should not be more than 12 by 12 by 20 inches.

c. The Diack Control. Every load that goes through the autoclave is provided with a Diack control. The Diack control is a tablet of chemical substance, sealed in a small glass tube. The tablet fuses or melts if exposed to a temperature of 250 degrees F., for 2.8 to 3.2 minutes, or 246 degrees F., for 27 to 35 minutes. At 242 degrees F., it will not melt. Nothing but heat can cause fusion of the control. These characteristics indicate that the above temperature has been reached in the area of the Diack control. The coolest section of any sterilizer is always at the bottom, near the door. The part of the load hardest for steam to penetrate is the center of the largest, most tightly wrapped package at the bottom of the sterilizer. Diack controls may be placed in various locations in the autoclave and inspected immediately after the load is removed from the autoclave and before any of the load is taken away. Many other forms of detection of adequate sterilization of articles by steam are available. Usually they depend upon a change of color or consistency of the test substance. The control in or on the package should always be checked before using the contents on a patient.

91. Chain of Asepsis

Sterile, or aseptic, technique is a term used to describe a procedure which seeks to prevent infection or the spread of infection by insur-

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ing that everything coming in contact with a break in the skin or a body cavity is sterile. The term "sterile" means the complete absence of all living microorganisms. Numerous procedures are performed on the ward which necessitate the use of sterile technique. To set up equipment properly for these sterile ward procedures and to assist with them or to perform them, the principles of sterile technique must be understood and practiced. The steps carried out to insure sterility are described as the "chain of aspesis." Each step is considered a link in the chain; if one step is violated, sterile technique collapses.

92. Principal Steps in Sterile Technique

a. Before beginning any sterile procedure, hands should be washed thoroughly to rinse off surface bacteria and should be made as clean as possible. The hand-washing procedure recommended by the hospital should be followed. For some sterile procedures, gloves should be used.

b. Only sterile supplies should be used. Supplies must have been sterilized by the best available method, stored, and handled properly to avoid contamination.

c. Equipment should be kept sterile during preparation for the procedure and while it is

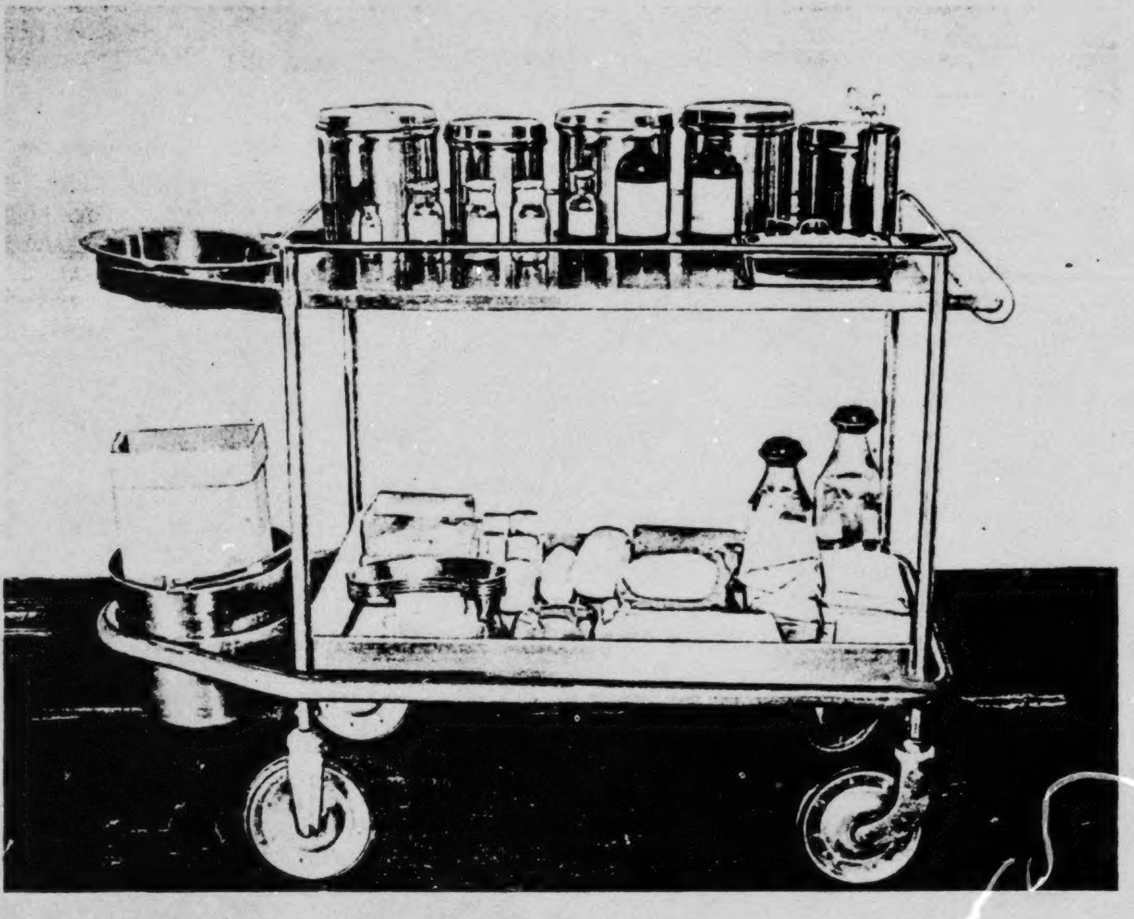

Figure 56. The dressing cart.

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being performed. The sterility of the articles in use should be maintained by handling them with sterile gloves or instruments.

d. Any object which becomes contaminated should be discarded. A sterile object that touches anything not sterile is considered contaminated.

93. Use of the Dressing Cart

One of the most frequent practices of aseptic technique on the ward is in the use of the dressing cart. This cart (fig. 56) is rolled to the patient's bed when a sterile procedure is to be performed or when a dressing is to be changed. It is a portable treatment room, stocked according to the needs of the ward. The cart must be prepared properly; it must be checked frequently for adequacy of supplies and for their sterility; and it must be cleaned routinely and kept ready and available at all times. Principles of aseptic technique must be followed when the cart is in use. Properly used, the dressing cart saves the time and energy of personnel; improperly used, it can spread infection from one patient to another.

94. Contents of the Dressing Cart

Certain areas of the dressing cart are specifically designated for sterile, clean, or soiled supplies. Sterile supplies properly packaged are kept on the top shelf and one section of the lower shelf. Clean supplies are kept on one section of the lower shelf. Soiled dressings are wrapped in newspaper or placed in a paper bag and discarded into the bucket. Used instruments, emesis basins, and the like are placed in the basin at the end of the cart. Clean unused dressings, towels, and other material which must be returned to the Centralized Materiel Section for resterilization are placed in the bag at the end of the cart under the adhesive rack. Soiled linen to be laundered is placed in the bag at the end of the cart. The cart usually contains sterile equipment, such as individually wrapped pads of various sizes, hand towels, packages of petrolatum gauze, tongue depressors, applicators, rubber drainage tubing and connectors, syringes, basins, and covered jars containing pads, sponges, safety pins, dressing sets, a transfer forceps in a container, antiseptics, ointments, and solutions. Unsterile equipment found on the cart usually includes such items as adhesive, bandage scissors, folded newspapers, assorted bandages, jars of pins, bandage fasteners, and rubber bands.

95. Handling the Transfer Forceps (fig. 57).

Transfer forceps are used to transfer sterile materials to the sterile field which has been set up for the patient. They are received sterile from the Centralized Materiel Section and are placed on the cart in their sterile container. The disinfectant solution in the container must always cover the hinge of the forceps, and the hinge must always be kept open while the forceps are in the solution. The transfer forceps have both a sterile and an unsterile section. The handle grasped by the user is unsterile; the end submerged in the solution is sterile. To carry out aseptic technique in using the dress-

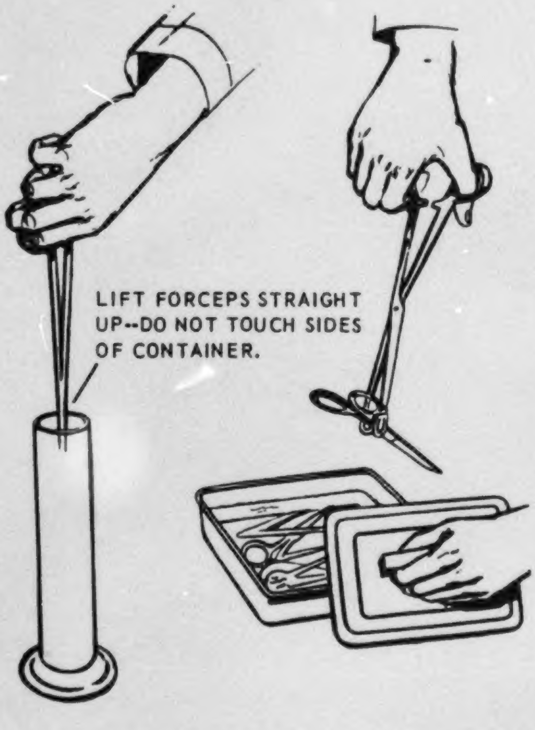
LIFT FORCEPS STRAIGHT UP--DO NOT TOUCH SIDES OF CONTAINER.

Figure 57. Handling the transfer forceps.

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ing cart, the transfer forceps must be handled correctly. They must be pointing downward at all times. If they are not pointing downward, the solution will run over the unsterile part and then back over the sterile part, contaminating the forceps.

96. Dressing a Clean Wound

a. Preparation of the Patient. Changing a dressing is an aseptic procedure. Hands must be washed thoroughly before applying any dressing and between each dressing. The dressing cart is taken to the patient, and the patient is prepared by explaining to him what is going to be done. If he is in a ward he should be screened and made as comfortable as possible, and then the area to be dressed should be exposed.

b. Setting up a Sterile Field. The dressing pack, the emesis basin, and some newspaper or paper bags are placed at the foot of the bed and a bottle of skin-cleaning solution is placed near the back of the bedside stand. Next, a sterile field is set up as follows:

(1) The dressing pack is opened. This should be done carefully so as not to touch the inside of the wrapper. (The wrapper is used as a sterile field. It is considered sterile within 1½ inch of its border.)

(2) With the transfer forceps the towel is moved to one side. (The towel may be used to cover the sterile field if there is some delay in beginning the procedure, or it may be placed under the wound to provide a clean field.)

(3) The dressing forceps should be picked up with the transfer forceps and placed so that the handle is just off the edge of the wrapper. This is done so that when the dressing forceps are picked up the field will not be contaminated.

(4) With the transfer forceps, any additional gauze squares that will be needed for the procedure should be removed from the jars on the cart and placed on the sterile field.

c. Changing the Dressing.

(1) The outer dressing is removed with the fingers. The skin is held taut and the adhesive is pulled off toward the wound.

(2) The dressing forceps is held in one hand and used to pick up the towel. The corner of the towel is grasped with the other hand. The forceps is returned to the dressing pack. The second corner of the towel is grasped and the towel is placed under the wound or next to it. The towel provides a sterile field.

(3) The inner dressing is removed with the forceps. The dressing and the wound are examined. The forceps are then discarded into the basin.

(4) Using another forceps, a 2-by 2-inch gauze sponge is picked up, held over the emesis basin, and a skin cleaning solution, such as hydrogen peroxide, is poured over it.

(5) The wound is cleaned around the edges (fig. 58), working outward from the wound edges without retracing. If necessary additional sponges are used. All sponges are discarded on the newspaper.

(6) The area is dried with additional 2-by 2-inch gauze sponges held in the same forceps.

(7) Gauze sponges are placed on the wound. The number and size of sponges will be determined by the size of the wound and the amount of drainage. The dressings should extend at least 2 inches beyond the wound edges on all sides.

(8) The dressing is secured with adhesive strips.

(9) The patient is made comfortable.

(10) All used instruments are placed in the soiled instrument basin. The towel and the wrapper are placed in the bag for return to CMS.

(11) The soiled dressing is wrapped securely in a newspaper and placed in the bucket on the cart.

(12) The cart is removed from the patient's unit.

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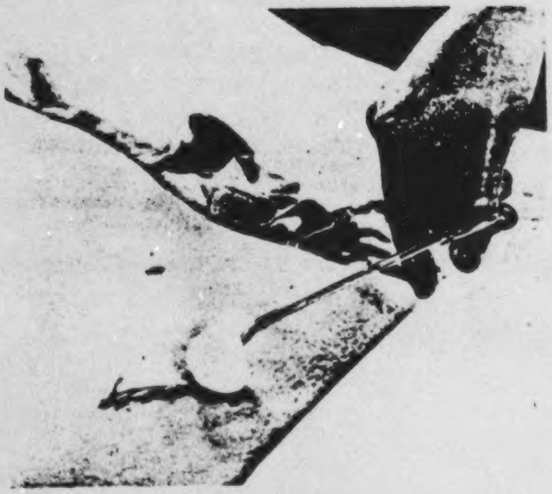

Figure 58. Cleaning the wound.

(13) Hands must be washed before going to the next patient.

97. Dressing Draining Wounds

a. A draining wound (dirty, septic, or infected wound) is dressed in the same manner as is the sterile wound. Every precaution must be taken to prevent the spread of the infection to other sites on the patient and to other personnel.

b. If the dressing is stuck to the edges of the wound, it should be loosened by moistening it with a sterile solution *only if ordered by the ward surgeon.* A sterile Asepto syringe set containing a small sterile basin is used for the solution. A sterile emesis or kidney basin is held beneath the dressing to prevent the solution from soiling the bed. As the crust becomes softened by the solution, the dressing should be gently lifted off with the forceps and discarded on waste paper. The forceps is then discarded into the emesis basin.

c. Draining wounds are often irrigated with peroxide or other antiseptic solutions, as-ordered. Sterile materials are used. The tip of the syringe is placed into the wound to wash out the pus. The drainage is caught in a basin held below the wound.

..e drainage from an infected wound is often irritating to the surrounding skin. Petrolatum gauze or other ointments may be ordered to protect the skin.

e. Wounds infected with virulent pathogenic bacteria, such as the gas bacillus in gas gangrene cases, call for absolute isolation technique. If a break in the dressing technique is permitted, all personnel involved are exposed to a most deadly germ.

(1) These patients should be isolated.
(2) A separate dressing tray or cart should be used.
(3) The wounds of these patients should be dressed *after* the "clean" ones. The best technique is to have one specialist care *only* for these seriously infected cases.
(4) Rubber gloves should be worn when applying the dressings.
(5) Change of dressing procedure is the same as previously described.
(6) All instruments used for the dressing are placed in a pan or basin as they are discarded. At the end of the dressing, all instruments are washed by a specialist wearing rubber gloves, and they must be pressure sterilized immediately. The basin is cared for in the same manner.

98. Securing the Dressing

For a dressing on the abdomen, an abdominal dressing (reinforced with an ABD pad) and strips of adhesive are used. The strips of adhesive tape should be wide enough to give support and prevent the pull of the muscles on the wound and sutures, and should be long enough to extend well around to either side. Adhesive tape must not be applied over an abraded skin. If it is necessary to do a daily dressing, measures should be taken to prevent skin irritation and discomfort to the patient caused by the daily removal of adhesive.

99. Bandages

a. Uses. A bandage is any flexible material used for the following purposes:

(1) To hold a dressing in place over a wound.

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(2) To fasten a splint to an injured part of the body.

(3) To create pressure over a wound for control of hemorrhage.

(4) To support (as a sling) an injured part.

(5) To supplement a dressing in protecting a wound from contamination.

b. Application. A bandage should never be applied directly over a wound, since it may not be sterile and would contaminate the wound. A sterile dressing should be applied first and then covered with a bandage. Other rules in bandaging are the following:

(1) Bandages should be applied evenly and firmly but not too tightly. A bandage that is loose may slip off entirely or may not hold the dressing in place. A bandage that is too tight may cut off circulation of blood in the injured part.

(2) When bandaging an arm or a leg, the bandaging is started below the wound and continued upward. Unless the fingers and toes are injured, they should be left exposed so they can be watched for signs of impaired circulation.

(3) The knots of bandages should be located where they are easy to reach and where they will not cause discomfort.

(4) Once a bandage has been applied, it should be examined frequently to see if it is secure. If it is too loose or too tight, the bandage should be reapplied.

c. Butterfly Suture. Some minor lacerations or incisions can be closed readily with specially prepared strips of adhesive tape called *butterfly sutures.* This technique may be used when a wound is superficial, has no muscle damage, and is located on a flat surface where there is no unusual stress or pulling. *A physician must be consulted before using a butterfly suture.*

(1) To make a butterfly suture, a strip of adhesive tape suitable in length and width for the wound is used. In each side, two diagonal slashes are cut toward the center of the strip. Then the cut edges (or flaps) are folded under. Before applying the suture, the folded edges are painted with an antiseptic solution, or passed slowly through a flame. Another way to make a butterfly suture is to fold a strip of tape back on itself and then cut the corners from the folded end to form wide nicks when the strip is unfolded.

(2) The wound area is cleaned. The butterfly suture is applied with pressure (fig. 59) and covered with a sterile dressing. When the wound has healed, the tape is removed gently to avoid pulling apart the edges of the wound.

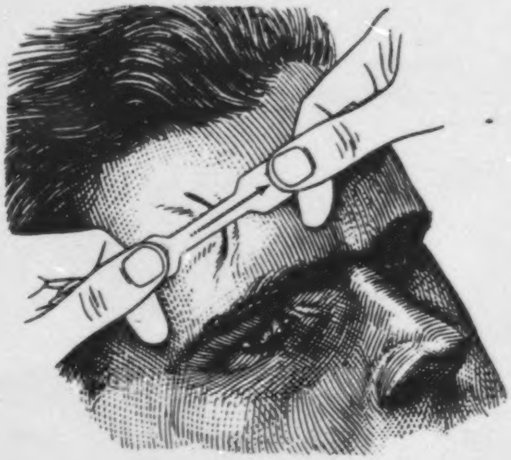

Figure 59. Closing a wound with a butterfly suture.

100. Cleaning and Restocking the Dressing Cart

In some installations the dressing cart is set up and then replenished at the end of each day in the Centralized Materiel Section (CMS). In most hospitals, however, it is cleaned by the specialist at the end of each day and is replenished as needed by supplies ordered from CMS. The following steps are involved:

a. Care of the Cart After Each Use. The soiled areas on the cart are cleaned, all supplies are put in their proper places, and items are restocked as needed.

b. Cleaning and Restocking the Cart Daily. Everything is removed from the cart and the cart is washed thoroughly. The bag containing wrappers, towels, and clean dressings is emptied and the contents disposed of according to hospital procedure. The bag of soiled dressings is emptied and replaced with a clean bag. The bucket is emptied, washed, dried, and replaced. Instruments and emesis basins are rinsed in cold water, washed with soap and water, rinsed, dried, and put in a designated place to send back to CMS. The transfer forceps is replaced, the dates are checked on sterile supplies, and any items whose sterile period has expired are returned to CMS for resterilizing. All supplies are replaced according to the clinic standing operating procedure. A check card tied to the cart is used to make sure all needed supplies are present.

PART TWO

CASTS, TRACTION, AND PATIENT CARE

CHAPTER 7

GENERAL

101. Casts

a. A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing the plaster to harden. Casts may be used to immobilize and hold fractures in place, to maintain alinement, to prevent movement of soft tissue injuries, and for correction, for example, clubfoot. The orthopedic specialist must learn certain basic techniques used in the application of casts; however, skill in this area is acquired chiefly through experience.

b. Plaster of paris is also used to hold orthopedic appliances. The plaster is applied to the body part and a cylindrical type of negative print is made of the part. A second material is poured into the cylinder, and when hardened becomes a positive or identical mold of the part. This mold is used as an aid in the building of exactly fitting orthopedic appliances.

102. Traction

Traction is the drawing or exertion of pull on apart of the body. It is used to overcome muscle contraction and associated shortening by regaining and maintaining the normal length of the bones. Traction is accomplished by the use of weights and pulleys. It is applied to the skin or to the bones. When some types of casts are used, traction is required.

CHAPTER 8

BASIC CAST SUPPLIES AND EQUIPMENT

103. Plaster of Paris, Powder Form

Plaster of paris, orthopedic and dental modeling, is used to make casts, to supplement the use of plaster impregnated splints and bandages in making casts, and to make molds for holding orthopedic appliances.

104. Plaster Bandages, Splints and Patterns

a. Bandages, Cotton, Plaster of Paris Impregnated. These bandages or rolls are available in widths of 2, 3, 4, and 6 inches. They have an extra fast setting speed (2 or 4 minutes) and a fast setting speed (5 to 8 minutes). Supplies should include 2- and 3-inch rolls (extra fast setting) and 3-, 4-, and 6-inch rolls (fast setting). There is also a 6-inch width which has a slow setting speed (10 to 18 minutes), but it is rarely used.

b. Splints, Plaster of Paris Impregnated for Arm and Leg. These splints are straight pieces of crinoline impregnated with plaster of paris. They are short and narrow (3 by 15 inches), short and wide (4 by 15 inches), and long and wide (5 by 30 inches). Plaster splints are useful in reinforcing casts and in reducing the time for application.

c. Patterns, Impregnated With Plaster of Paris. A plaster pattern can be made by cutting a pattern of the part from cotton material and dipping the pattern in plaster of paris.

105. Padding Materials

a. Stockinet, surgical, is made of tubular-shaped, seamless rib knit material of natural color. It is available in widths of 3, 6, 10, and 12 inches. Stockinet is useful as a thin padding next to the skin, and it helps to make a close-fitting, contoured cast.

b. Wadding, cotton, surgical, available in widths of 5 inches by 6 yards, can be used as padding for casts.

c. Bandages, webril, available in 2, 3, 4, and 6 inches by 4 yards, are also used as padding. In chapters 10, 11, and 12, which discuss the application of specific types of casts, either cotton wadding or webril bandage can be used as padding materials.

d. Bandages, felt, orthopedic, are used under casts for padding bony prominences. The felt bandage has a cohesive fiber surface. It is available in large white rolls and can be split into the thickness and cut into the size and shape required. It is available in cotton and viscose rayon in widths of 2 to 6 inches by 4 yards. Felt is also available in sheets of gray wool, ½ inch thick.

106. Miscellaneous Materials

Other materials include 5-inch rolls of muslin, cut on the bias, tincture of benzoin or Ace adherent, surgical moleskin, talcum powder, lotion, sponge rubber, and other materials required by the specific department.

107. Cutters and Knives

a. The *cutter, orthopedic cast, electric,* is used for cutting casts. The blades of the electric cutter are 2 inches and 2½ inches. There should be three or four electric cutters in the cast room.

b. Knives of various types are used for trimming casts. The *knife, compound, dental,* with detachable blade No. 21, is easy to handle and trims casts neatly.

108. Spreaders, Benders, Scissors, and Pliers

Spreaders are used for spreading the edges of casts, and benders are used for bending back the edges. There should be at least four pairs of spreaders (two large and two small), two benders, a large bandage scissors, and a pair of ordinary pliers in the cast room.

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109. Tables and Carts

a. Worktables. Worktables used in the cast room have metal surfaces which can be easily cleaned. On these surfaces, plaster splints can be rubbed smooth. Worktables must be kept clean at all times.

b. Plaster Cart. The plaster cart is useful, since it can be moved about in the cast room and can be moved into the wards when patients cannot be moved into the cast room. It must be kept clean and well supplied at all times.

c. Orthopedic Tables. The *Albee-Compere* table is the orthopedic table in general use. It is used for adults and for large children, but will accommodate small children for the application of hip spicas, Calot or body jackets, and Minerva jackets. The *Risser* table and sometimes the *Mills* table are used for small children. The Risser table is specially designed for children and adults for application of corrective casts in the treatment of scoliosis. The small *portable spica* table is useful for applying hip spica casts and for frogleg casts for congenital dislocation of the hip. The perineal post and sacral seat are always padded. The portable spica table can be constructed according to the specifications of the physician.

110. Miscellaneous Equipment

Other equipment needed includes the following:

a. Examination table.

b. Stools, 24 and 36 inches in height.

c. Metal splints for splinting finger fractures.

d. Heels, for walking type casts.

e. Bucket, 8 quart.

f. Two pillows, plastic covered.

111. Care of Equipment

All equipment must be cleaned after each use, oiled regularly, kept in the proper place, and inspected weekly. To allow full use of the electric cutter, the blade should be removed when it gets dull and turned over, exposing the sharp part of the blade. Since only half of the blade is used at a time, this will allow full use of the blade. To determine when the blade is dull, it should be rubbed between the index finger and the thumb. If it feels slick it should be changed.

CHAPTER 9

BASIC CAST TECHNIQUES

112. General

a. In the application of a cast, the orthopedic specialist must first be concerned with the physician's orders. He must make sure he understands the orders and then make every effort to follow them carefully and accurately.

b. A cast must never be applied or altered without the physician's order.

c. The patient's treatment must never be discussed with the patient.

d. A cast should be applied with the body part in a position of function, unless otherwise ordered.

e. In applying a cast, it must be kept in mind that the cast should usually extend above and below the joint from the site of the fracture.

f. Before applying a cast and before recasting, the skin on the area to be covered must be checked carefully. Any unusual conditions, such as drainage, blisters, pressure sores, and rashes, must be reported to the physician.

g. Under normal conditions to check the alinement of the lower limb, a string is run from between the first and second toes through the patella to the crest of the ilium. If these do not line up, the other leg should be checked for comparison.

113. Basic Factors To Be Considered in Using Plaster of Paris

a. Plaster of paris is a derivative of gypsum, or calcium sulfate. Gypsum, which contains several parts of water, is ground to a fine powder and some of the water is driven off by heat. Chemicals are added to this dehydrated powder in varying quantities, thus affecting the time required for the plaster to set after placing it into the water. During the setting time, long cylindrical crystals are formed and interlock with each other to make a strong cast. For this reason, the cast should not be moved before it has set, so as to prevent the breaking up of these crystals and thus prevent weakening of the cast.

b. The setting time of plaster is retarded by the following:

(1) Too much water left in the plaster roll.
(2) Sugar added to the water.
(3) Cold water added.

c. The setting time of plaster is accelerated by the following:

(1) Too much water removed from the plaster roll.
(2) Table salt added to the water.
(3) Rubbing and working with the plaster as it is being applied.
(4) Hot water added (not over 80 degrees).

114. Positioning the Patient

Positioning the patient is one of the most important procedures in casting. First, every attempt should be made to get the patient to relax. Unless the physician orders otherwise, the lower limb should be cast with about 5 to 15 degrees flexion at the knee and 90 degrees at the ankle. There should be no inversion or eversion at the ankle. It may be difficult to get the foot up to a 90-degree angle. Flexing of the knee will help to get the foot in this position. In contractures of joints, a number of wedgings may be necessary to get full extension of the limb. Natural position in the upper limb is about 15 degrees, cocked-up at the wrist, similar to holding a water glass, and a 90-degree angle at the elbow. Specific positions for the different types of casts are discussed in chapters 10, 11, and 12.

115. Padding the Cast

The purpose of padding a cast is to provide more comfort for the patient, to lessen the possibility of pressure sores, and to make it easier and safer to remove the cast.

a. Stockinet may be used next to the skin as a padding material for a close-fitting and well-contoured cast. It should not be used alone for acute fractures, where there is excessive swelling, or immediately after an operation, since it tends to constrict and may impair circulation. If stockinet is used without additional padding, the fact should be noted with indelible pencil on the cast, so that when the cast is removed the electric cutter will be used with caution.

b. Sheet cotton or webril bandage can be wrapped over the stockinet in one to three layers. It should be rolled on smoothly with the turns overlapping about one-half the width of the bandage.

c. Bony prominences are then padded with pieces of felt which have been cut for the specific parts. In all casts, bony areas are padded to help prevent pressure sores.

116. Dipping and Squeezing the Plaster Bandage Roll

The roll should be held between the thumb and index finger. It can be held with one or both hands. The roll should be in a vertical position to allow air to escape through the core of the roll.

a. The bandage roll should be dipped in a bucket of tepid water (about 70 to 80 degrees F) for about 5 seconds or when the water stops bubbling. The longer it is soaked, the shorter the setting time.

b. Then it is held at each end and squeezed, not wrung. It should be squeezed at the ends, pushing toward the center. This will force the water through the roll. Enough water is left in the roll to insure application before it sets or gets too dry to work.

117. Rolling the Plaster Bandage

The skin should be checked before applying the plaster roll. The correct sized roll should be used for the area to be covered. The plaster bandage should be rolled with the roll resting on the patient. It should be rolled smoothly and snugly, keeping the pressure equally distributed through the entire width of the plaster roll. As many rolls as necessary to make a good cast are used.

a. Each turn should overlap the preceding one by one-fourth to one-half of the width.

b. To guide or change the direction of the roll so as to contour the plaster smoothly, a tuck can be made by pulling the plaster up, making the tuck, and smoothing it until it is flat.

c. Plaster should be applied within 2 inches of the edge of the stockinet or ½ inch of the edge of the sheet wadding or webril bandage.

118. Rubbing the Plaster Bandage

Rubbing the plaster bandage is an important step in the application of a cast. The plaster bandage should be rubbed smooth as it is applied, so that the layers blend smoothly. Rubbing each layer of plaster in the direction in which it is being rolled will result in a solid, strong, and well-fitting cast.

119. Applying the Plaster Splint

Splints may be applied to joint areas or where additional strength is desired.

a. The plaster splint is dipped in water and withdrawn rapidly.

b. It is placed on the worktable and smoothed firmly with the palm of the hand.

c. Each side of the splint is then drawn through the index and middle fingers.

d. The splint is always tied in with plaster bandage.

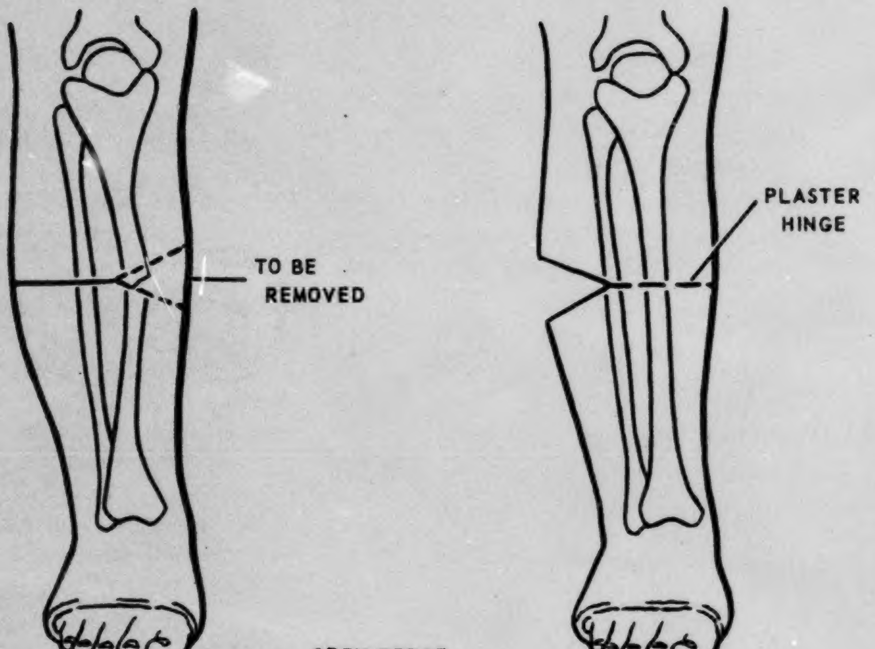
120. Molding the Cast

The plaster is rubbed and molded over the contour of the body part until it is firmly set. It should be molded well around joint areas.

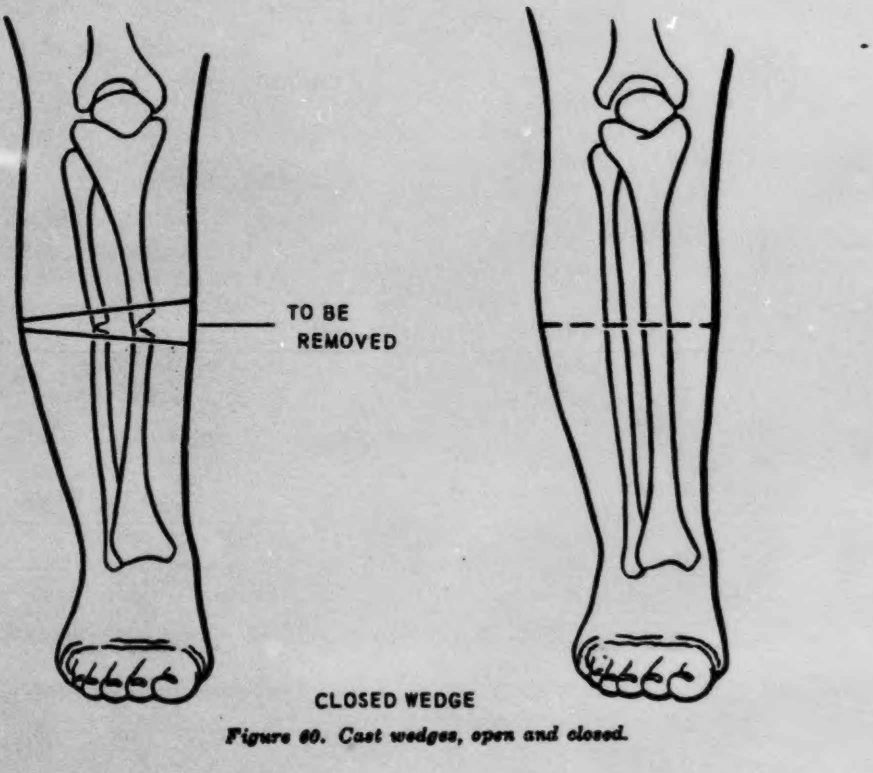
a. A few drops of water may be applied to make the surface smooth.

b. Plaster crumbs should be washed off the operator's hands, since these crumbs cause rough spots in the cast.

c. Molding continues until the setting point


TO BE
REMOVED
PLASTER
HINGE

OPEN WEDGE


TO BE
REMOVED

CLOSED WEDGE

Figure 60. Cast wedges, open and closed.

of the plaster is reached, or when the plaster is no longer glossy and creamy.

d. The cast should be ventilated while setting to allow dissipation of heat.

121. Finishing the Cast

a. The cast is trimmed with a sharp knife.

b. The edges of the stockinet are folded over, covered with a plaster splint, and smoothed.

c. The patient in a freshly made cast is placed on pillows to avoid contact with rough surfaces, which would dent the cast.

122. Wedging the Cast

Wedges are used in the cast to correct either bone or soft tissue deformities.

a. A *closed wedge* is one in which a segment of a cast is removed and then the opening is closed.

b. An *open wedge* is one in which the cast is cut in two sections, the sections pulled apart, and the open wedge filled in. Blocks of wood can be used to fill in open wedges. Plaster splints and plaster bandages are sometimes preferred. A piece of felt, cut in the orange peeling shape, can be used to fit into the wedge, which is then filled in with plaster splints. The splints are tied in with plaster bandage, with the cast held in the angle degree of the wedge until the setting stage is reached.

123. Attaching Struts to Casts

Struts are narrow pieces of wood which are attached to casts when it is necessary to join two limbs or to join one limb to the trunk.

a. The piece of wood is covered with a plaster splint and placed in position.

b. Plaster bandage is wrapped in a figure-of-eight around both the end of the strut and the cast part, and around the end of the strut over the figure-of-eight.

c. It is then wrapped around the strut and the cast end is molded.

124. Windowing the Cast

A window can be cut into a cast when it is necessary to dress wounds or to examine an area in which the patient complains of pain. Dressing techniques, removal of sutures, and relief of pressure can be accomplished without removing the cast but by cutting a window over the area. The window is cut with an electric cutter and later held in place with adhesive or elastic bandage. A window can be permanently replaced by holding it in position and wrapping it to the cast with plaster bandage.

125. Bivalving the Cast

In bivalving a cast, the cast is cut on both sides. The bivalved parts of the cast can be used as splints in the treatment of muscle contraction, muscle spasm, and drop foot. They can also be used as night splints.

a. The cast of the lower limb is cut laterally and medially, with the cut extended anterior to the malleoli, so as to prevent the foot piece from breaking off.

b. The cast for the upper limb is cut down the lateral and medial sides. If it is a short arm cast, it is cut down the ulnar and radial sides. The medial section which remains can then be used as a posterior splint if necessary.

c. The bivalved parts are lined with sheet wadding or webril bandage and covered with stockinet, which is sewed over each end. The parts can then be strapped over the limb.

126. Splitting the Cast

If a cast becomes too tight and elevation will not reduce the swelling and if the cast is not ready to be removed, it can be split and spread. If splitting becomes necessary, it is necessary to cut the base material or padding down to the skin, since this is sometimes the source of the trouble.

127. Removing the Cast

a. Casts can be removed by using any of several methods. The simplest but not the easiest method is to soak the cast in water, find the end of the last roll, and unravel it and the other rolls.

b. Casts can also be removed by making grooves in them, pouring peroxide into the grooves, and then cutting the layers of plaster with a knife.

c. Hand cutters can be used to remove casts, but their use requires much effort if the cast is heavy.

d. The most widely used method of removing a cast is with the electric cast cutter. The electric cast cutter is not dangerous to use if it is used correctly. When removing the cast, the cutter should be held so that the depth of the cut can be gaged. The thumb should rest on the cast. Care must be exercised in cutting over areas where the bones are close to the surface of the skin. All casts with light padding should be marked as such with indelible pencil so that the cutting will be done with caution.

128. Precautions

When applying casts, many serious errors can be avoided by keeping in mind certain precautions, some examples of which are the following:

a. After the plaster has begun to set, no attempt should be made to correct a position.

b. The position of a joint should not be allowed to change (flex or extend) during the application of a cast or while waiting for the plaster to set. Movement will cause wrinkles in the plaster, which can cause pressure sores or even skin sloughs.

c. Circular dressings of cloth, adhesive, moleskin, elastic bandage, or any other material should not be placed under the cast.

d. In the application of plaster, the wet roll should not be stretched or pulled to make the layers snug, to flatten folds, or to make the plaster conform to the bony prominences or fossae. Instead it should be molded.

e. To hold a wet cast, the palm of the hand (not the tips of the fingers) should be used.

f. All plaster generates considerable heat on setting, and for this reason maximum exposure to air is indicated while the cast is drying. This precaution is especially necessary in the treatment of unconscious or anesthetized patients.

129. Transferring the Patient in a Cast

In transferring patients in casts, the X-rays, charts, and case histories of the patients may not accompany them, so it would be to the advantage of the receiving institution or physician if the following information were recorded on the cast:

a. Date of injury.

b. Date of operation.

c. Date of each casting.

d. The outline of the fracture drawn on the cast at the fracture site.

130. Instructions for the Patient

a. Cast Care.
  (1) Do not walk on new walking casts for a period of 24 hours.
  (2) Keep all casts dry.
  (3) Do not alter casts.
  (4) Do not remove casts.
  (5) Do not put foreign objects inside of casts.

b. Prevention of Complications.
  (1) To prevent swelling when a cast is applied to a limb, elevate the limb for 2 days.
  (2) Report pressure points.
  (3) If a cast becomes soft or broken, return for repairs.
  (4) If a cast becomes too loose, return for a new one.
  (5) If in doubt, return to have the cast checked.
  (6) Follow the physician's orders.

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CHAPTER 10

UPPER LIMB CASTS

131. Standard Short Arm Cast

The standard short arm cast is applied from the distal end of the knuckles and the distal palmar crease to 1 inch below the bend of the elbow (fig. 61).

a. Stockinet, 3 by 18 inches, with a hole cut for the thumb, is rolled on the arm and the thumb inserted through the hole.

b. A roll of cotton wadding, 4 inches, or webril bandage, 3 inches, is applied, overlapping about one-half the width of each turn.

c. Padding is placed over the styloid of the ulna.

d. Three 3-inch plaster bandage rolls are applied, overlapping about one-half the width of each turn. A tuck is made at the back of the arm and rubbed smooth. Before wrapping the last turn of the plaster bandage, the stockinet should be folded back over the top of the plaster to protect the skin from any rough edges of the plaster.

e. The use of plaster splints for reinforcing the cast is optional. If used, the splint is applied anteriorly from the distal palmar crease to below the elbow and then tied in with plaster bandage.

f. To permit normal function of the thumb and the fingers, the plaster is trimmed away from the thumb, to the distal palmar crease on the inside of the hand, and to the metacarpal joints of the knuckles on the back of the hand. The thumb should have freedom of movement around the base. The patient should be able to touch the thumb with all the fingers.

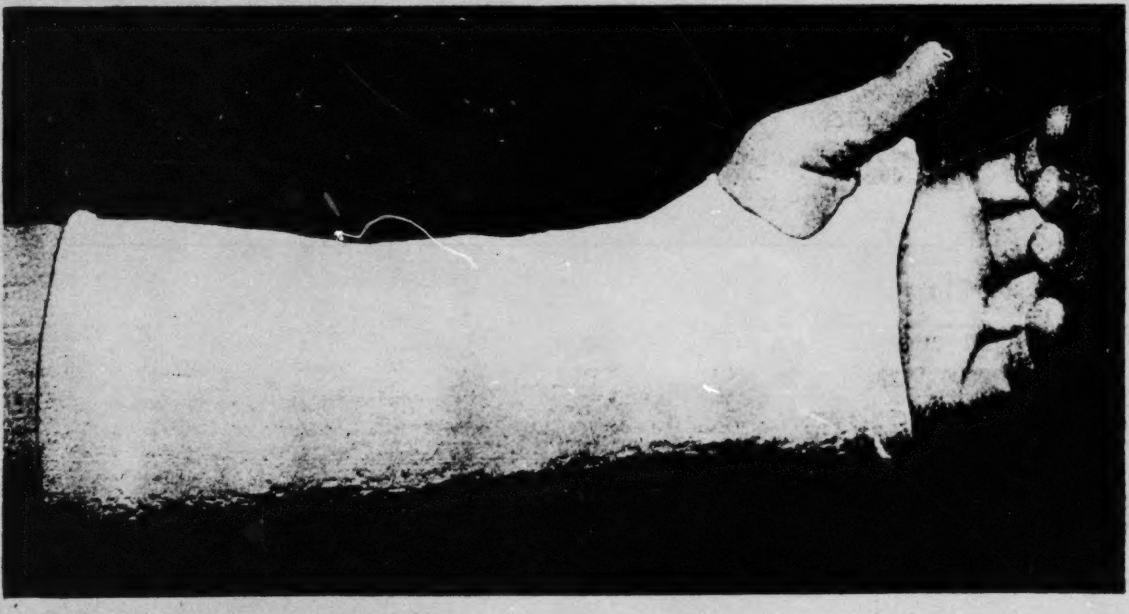

Figure 61. Standard short arm cast.

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132. Short Arm Navicular Cast (Thumb Spica)

The short arm navicular cast (thumb spica) is applied as is the standard short arm cast except that the thumb is included in the cast.

a. In addition to the materials used for the short arm cast, a roll of plaster bandage, 2 inches, is used.

b. The thumb should oppose the index finger as if the patient were holding a water glass (fig. 62).

c. In nonunions and sometimes after surgery, the physician may request that the index and middle fingers be included in the cast along with the thumb.

d. The fingers should be cast in a position of function.

133. Short Arm Cast (Boxer Type)

This cast is applied as is the short arm cast except that a finger or fingers are immobolized (fig. 63). The fingernails on the fingers to be cast should be cut short. This is a dangerous cast which is rarely indicated. It should be applied only by the physician.

a. The cast should be well padded. If two or more fingers are to be immobilized, some gauze or cotton wadding should be placed between them. A long strip of felt should be placed over the dorsal surface of the finger to be cast.

b. The metacarpophalangeal joint and the proximal interphalangeal joint are cast in 90-degree angles, with pressure applied to the back of the fractured finger, proximal to the fracture, and the pressure applied upward on the interphalangeal joints.

c. The cast is trimmed as is the short arm cast except for the fingers. It is trimmed so that the circulation in the fingers can be checked.

134. Short Arm Splint (Sugar Tong)

This cast is applied with plaster splints instead of plaster bandage rolls (fig. 64).

a. A splint is made using about ten thicknesses of splints which are long enough to

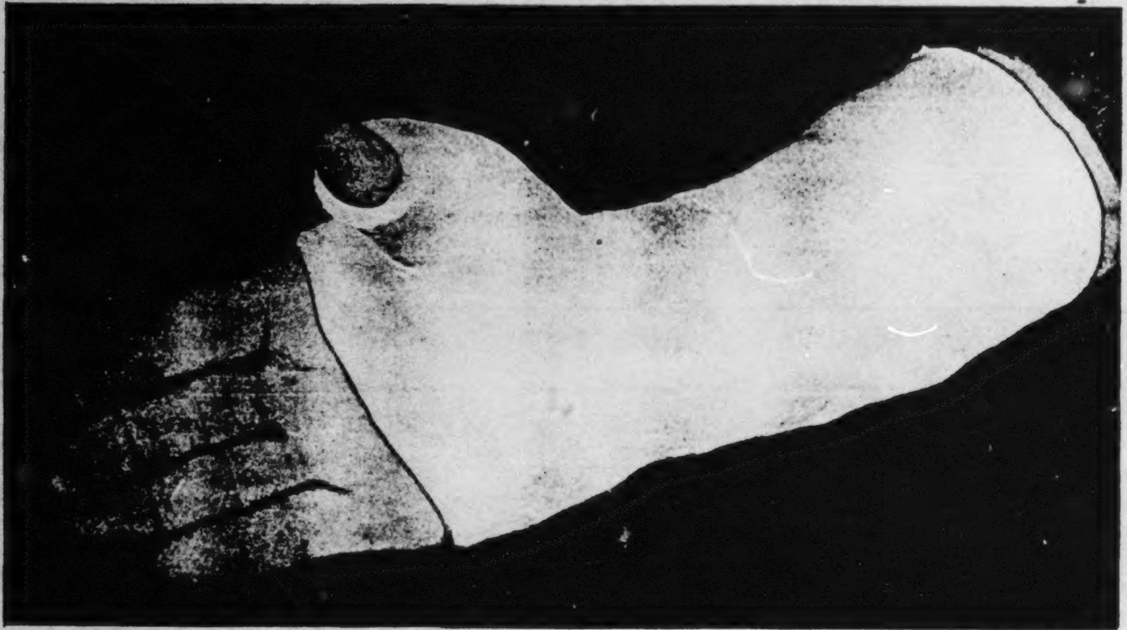

Figure 62. Short arm navicular cast (thumb spica).

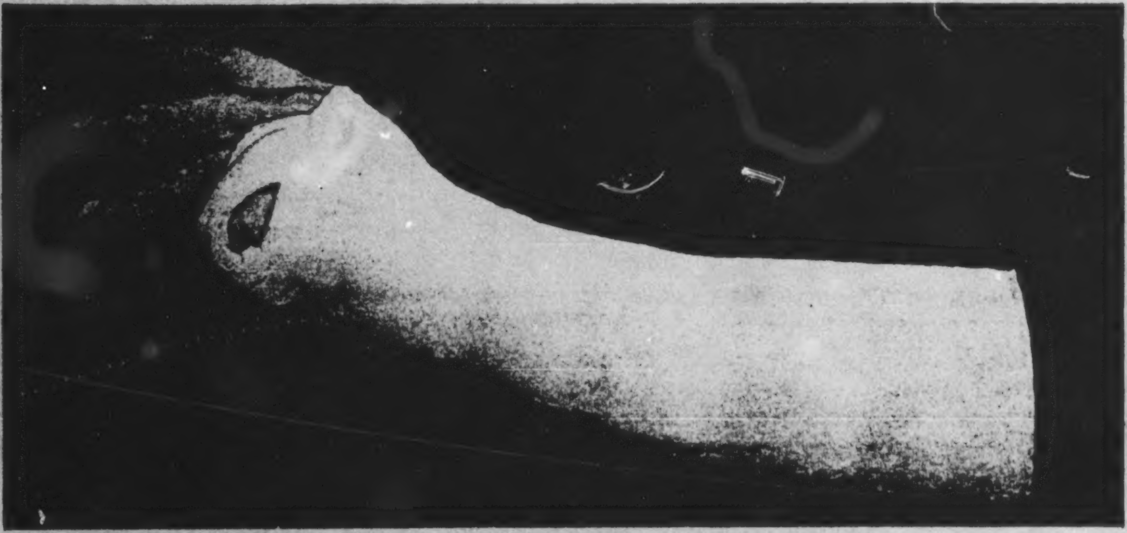

Figure 63. Short arm cast (boxer type).

extend from the metacarpophalangeal joints, up the forearm, around the elbow, and to the palmar crease.

b. The splint is rubbed and while still wet it is placed on the arm and held in position with an elastic bandage.

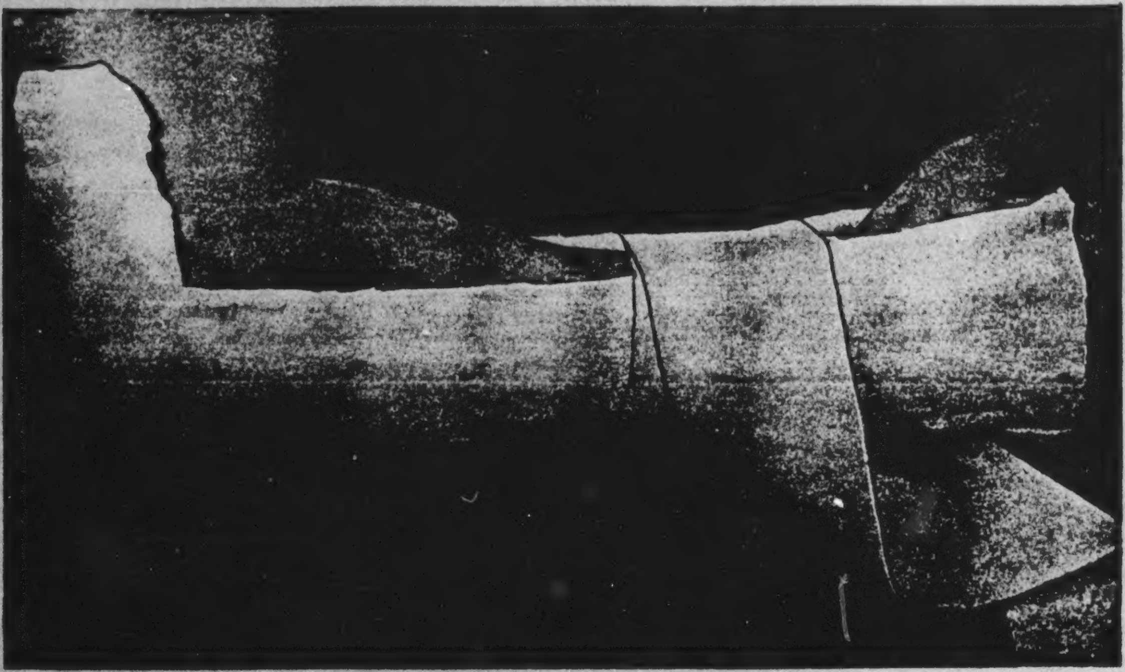

Figure 64. Short arm splint (sugar tong).

135. Short Arm Splint

a. The short arm splint, or wrist splint, is made using ten thicknesses of arm plaster splint which have been cut to fit around the thenar eminence (mound on the palm at the base of the thumb) (fig. 65).

b. The arm is wrapped with cotton wadding.

c. The wet splint is placed on the inner side of the forearm and wrist, and secured with a 3-inch elastic bandage roll, with the arm in a position of function. It must be possible for the elbow to move freely. The bandage must be snug but not tight. A check should be made for circulation.

d. The splint is trimmed as is the short arm cast.

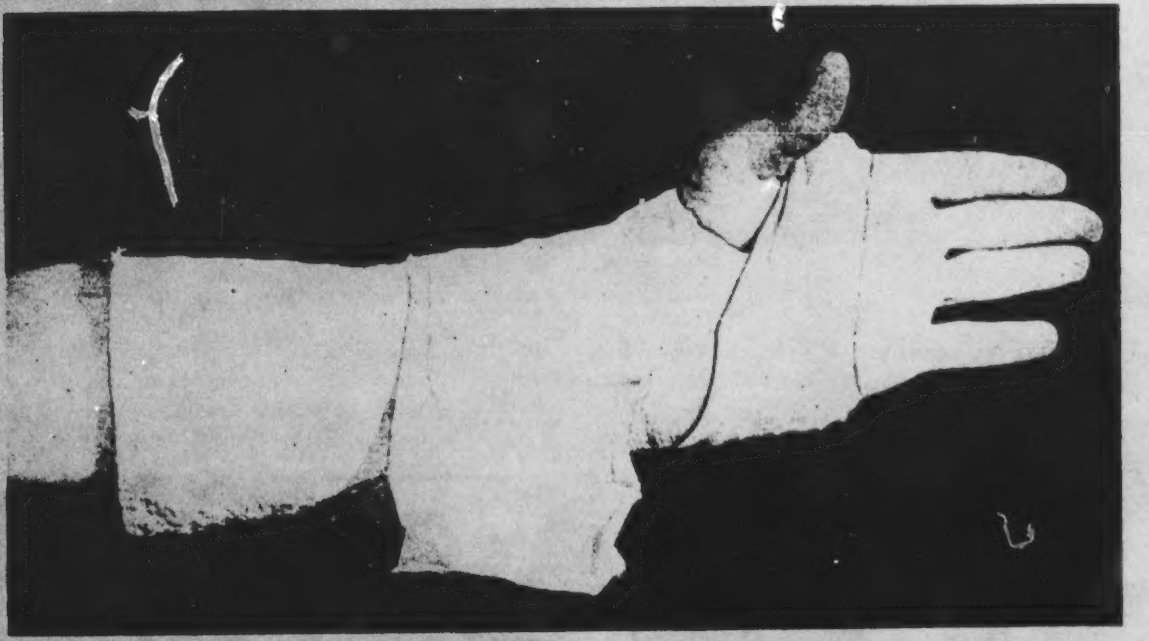

Figure 65. Short arm splint.

136. Short Arm Cast with Metal Finger Splint

This is a short arm cast (para 131) to which a metal finger splint is attached.

a. A short arm cast is applied and the plaster is cut away from the palm and thumb.

b. An aluminum splint, ½ inch to 1 inch wide and long enough to extend from the upper edge of the cast to about 2 inches past the fingertip, is wrapped with moleskin or tape. It is then bent to the shape of the anterior part of the cast and the finger, incorporated in the plaster, and applied on the palm side of the hand beneath the injured finger. After the plaster is set, the splint is bent at the wrist and further shaped to fit the palm of the hand and the finger. The fingers should be in a correct position to function, with the tip pointing to the navicular bone of the wrist. The end of the splint should be bent to cover and protect the fingertip and then bent backward to cover the end of the finger.

c. The splint is wrapped to the cast as far as the wrist with plaster bandage roll.

d. The finger is taped to the splint with three adhesive straps, inch by 3 inches, or

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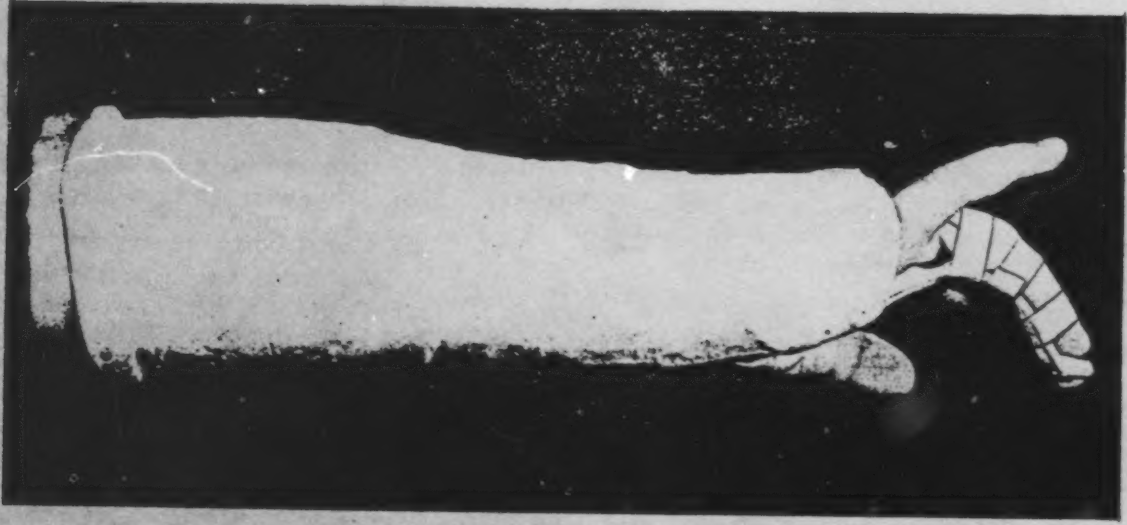

Figure 86. Short arm cast with metal finger splint.

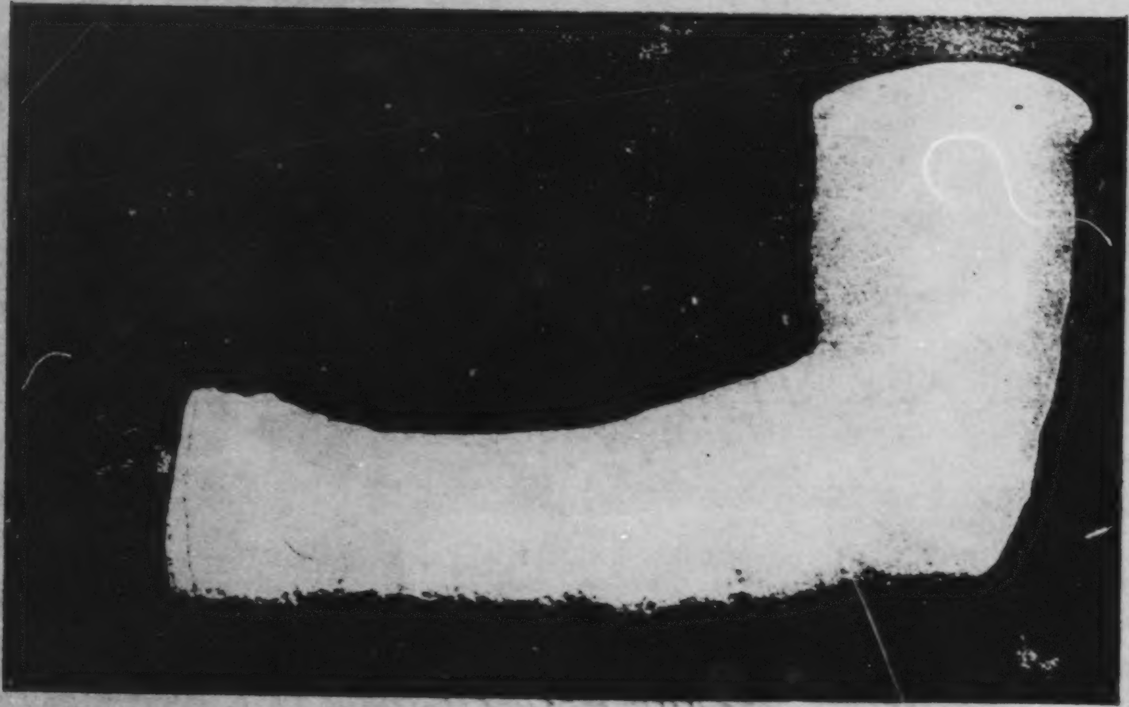

Figure 87. Standard long arm cast.

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wrapped to the splint with a 2-inch plaster bandage.

e. The splinted finger or fingers should be checked for circulation.

f. When traction is to be applied to the finger or metacarpals, the splint is not bent until the finger has been painted with tincture of benzoin, allowed to dry, and taped to the splint (fig. 66).

137. Standard Long Arm Cast

The long arm cast (fig. 67) is applied using the same general technique as is used in applying the short arm cast.

a. The long arm cast is applied from the palmar crease and metacarpophalangeal joints, proximally up the arm, to about 2 inches from the axilla.

b. The elbow is flexed to a 90-degree angle. The wrist is in a 15 degree cock-up position, with the back of the thumb toward the ceiling and the hand in a position of function.

c. Stockinet, 3 by 28 inches, and two rolls of cotton wadding, 4 inches, are applied, and the elbow and the head of the ulna are padded.

d. Six 3-inch rolls of plaster bandage are applied.

e. A short wide splint is applied posteriorly and tied in with plaster bandage.

138. Long Arm Hanging Cast

This cast is similar to the standard long arm cast except that it is suspended from the neck by a loop which is attached to the forearm (fig. 68). The weight of the cast depends upon the muscular development of the patient.

a. The hanging arm cast may extend down to the palmar crease or to the fourth metacarpal. When extended to the fourth metacarpal, it gives the wrist and hand a neutral hand rest position and allows all fingers and the thumb to move freely.

b. A wire loop is incorporated in the cast at a point proximal to the base of the thumb.

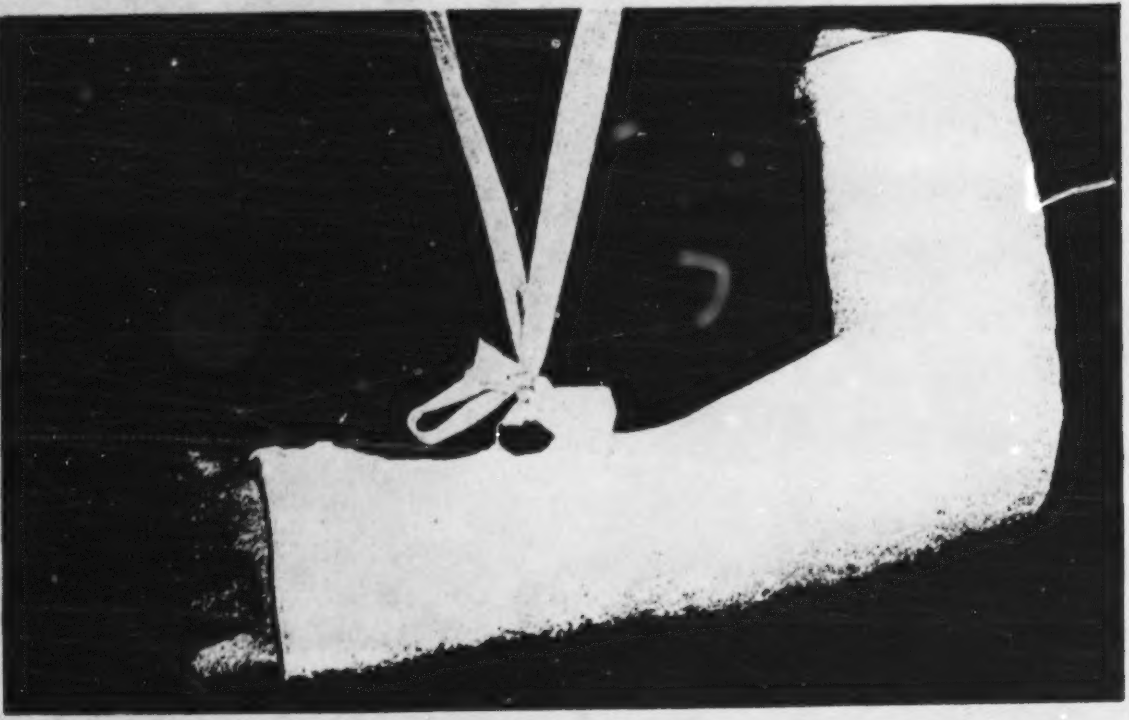

Figure 68. Long arm hanging cast.

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The weight of the cast and the location of the loop have a definite relationship to the reduction of the fracture. The physician's orders must be followed.

c. The cast is suspended from the neck by a loop which is alined to the midline of the body. A loop can be made, using about six thicknesses of webril bandage, a piece of white felt inserted in a tube or stockinet, or a padded ribbon. It should be about 40 inches long. The neck loop is inserted through the cast loop and each end of the sling is run in opposite directions and tied to the correct height, which is usually determined by the physician.

139. Long Arm Navicular Cast (Thumb Spica)

The cast is applied as is the long arm cast except with the thumb included. As in the short arm navicular cast (thumb spica), the thumb is cast as if the patient were holding a water glass. The elbow is at 90 degrees of flexion and the wrist is at 15 degrees of flexion (fig. 69).

a. In addition to the materials used for a long arm cast, two 2-inch rolls of plaster bandage and a small plaster splint cut for the thumb are used.

b. For complete immobilization, the index finger and the middle finger should be cast together, with gauze or cotton wadding placed between them.

c. The cast is trimmed so that the tip of the thumb is exposed and is trimmed to the metacarpophalangeal joints and the palmar crease.

d. The fingers and the tip of the thumb should be checked for circulation.

140. Long Arm Cylinder Cast

This cast is similar to the long arm cast, except that it ends at a point just above the wrist (fig. 70).

a. Stockinet, 30 inches long, two 4-inch rolls of plaster bandage, and a 4-inch roll of cotton wadding are used.

b. The elbow is well padded.

c. The excess stockinet is turned back and

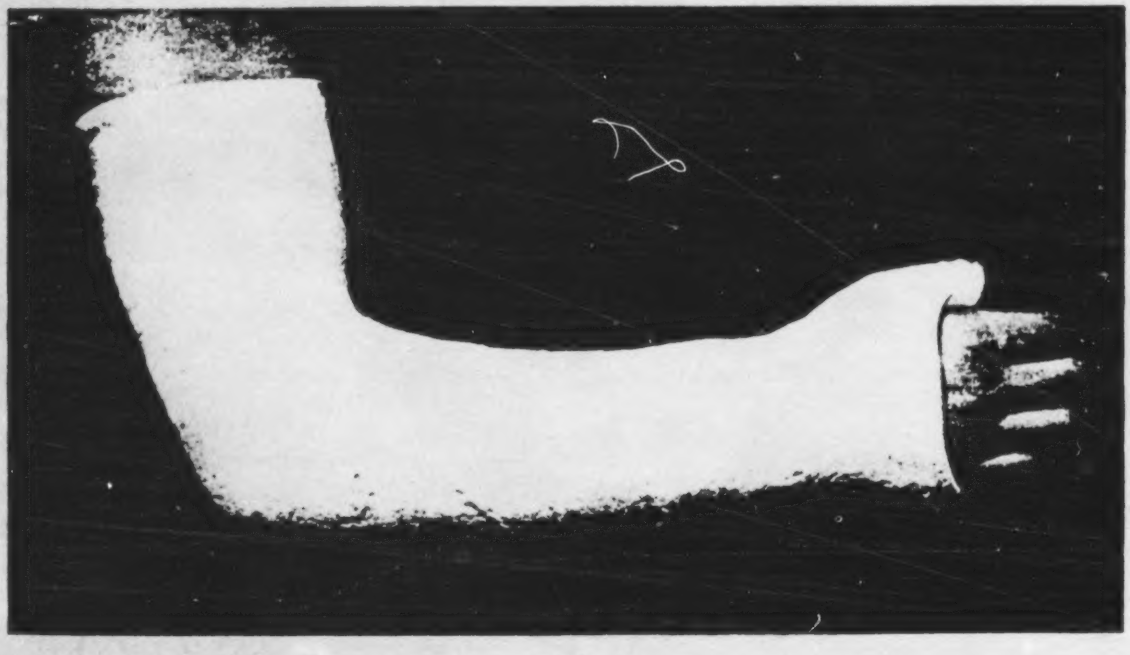

Figure 69. Long arm navicular cast (thumb spica).

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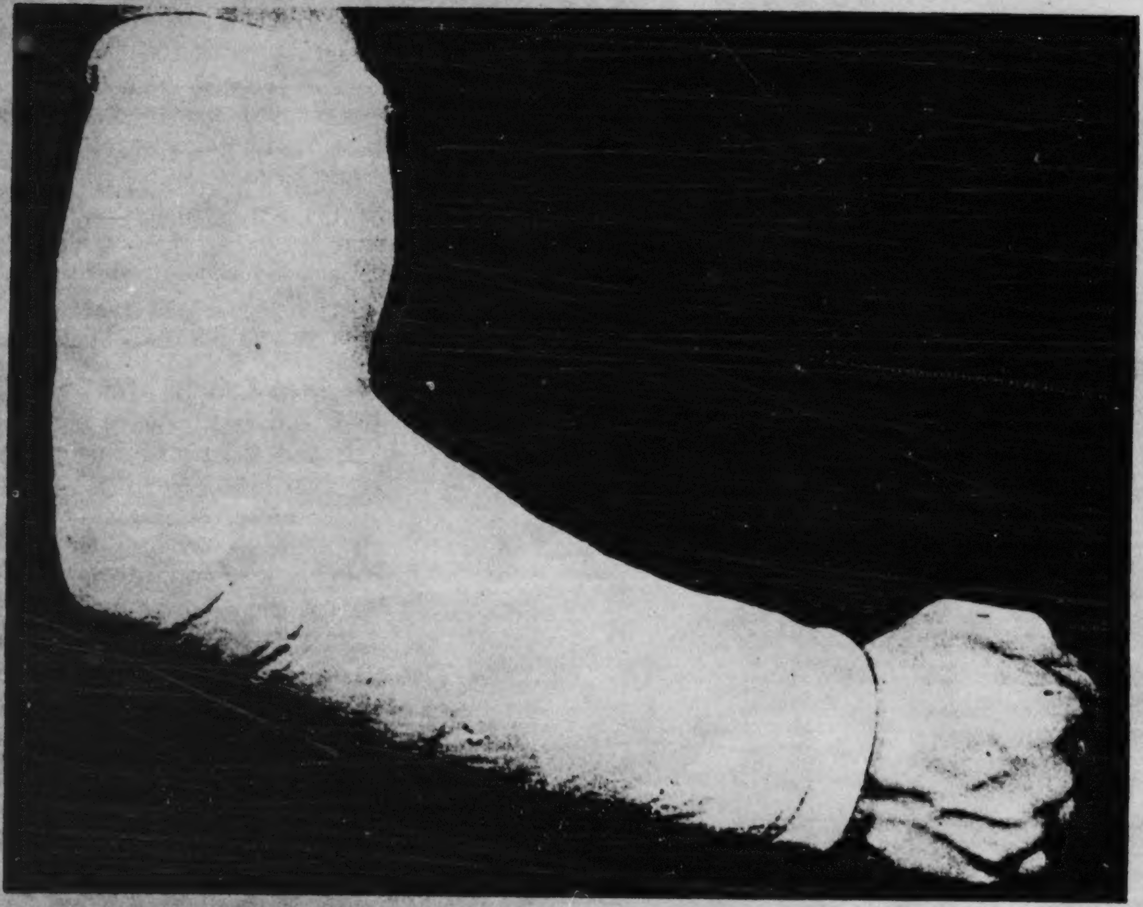

Figure 70. Long arm cylinder cast.

incorporated into the cast with the last roll of plaster bandage.

d. The fingers should be checked for circulation.

141. Long Arm Splint (Sugar Tong)

A short arm splint (sugar tong) (para 134) is first applied using plaster splints instead of plaster rolls.

a. The upper arm is wrapped in two rolls of cotton wadding.

b. A plaster splint of about ten thicknesses is applied from the metacarpophalangeal joints, around the back of the elbow, and to the palmar crease.

c. A second splint is placed about 2 inches from the axilla, extended under the elbow, then run up the outside of the arm to the height of the other end of the splint.

d. The elbow is held at a 90 degree angle while two 3-inch elastic bandages are applied to hold it in place (fig. 71).

e. Adhesive tape should be used to secure the elastic bandage since the regular metal clips which are furnished with the bandage can be easily lost or knocked off by the movement of the patient.

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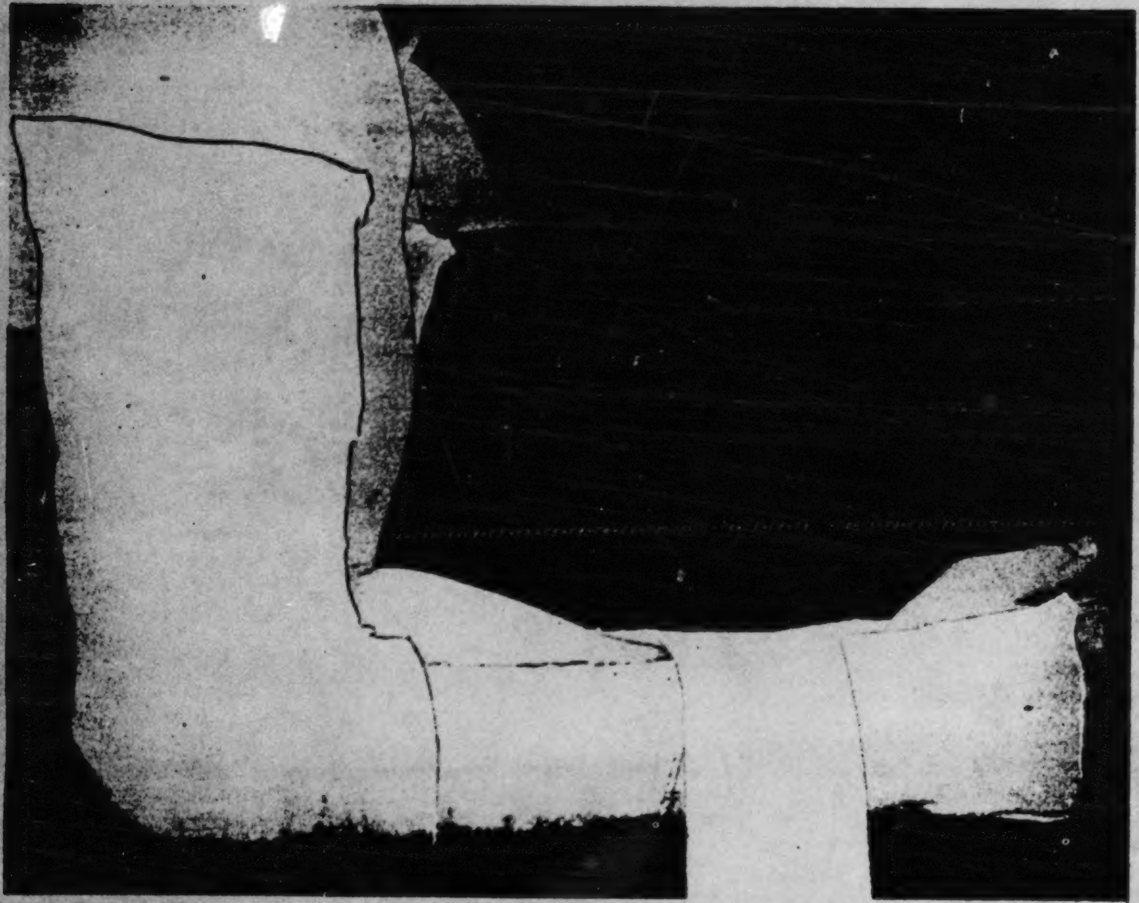

Figure 71. Long arm splint (sugar tong).

142. Long Arm Splint

a. The long arm splint extends from the axilla to the palmar crease. It is normally placed on the posterior surface of the arm, with the elbow at a 90-degree angle and the wrist at an angle of 15 degrees (fig. 72).

b. The arm is wrapped in cotton wadding and the elbow is padded well.

c. Two wet plaster leg splints, opened to full length are placed between layers of cotton wadding, applied to the limb, and held in place with a 4-inch elastic bandage.

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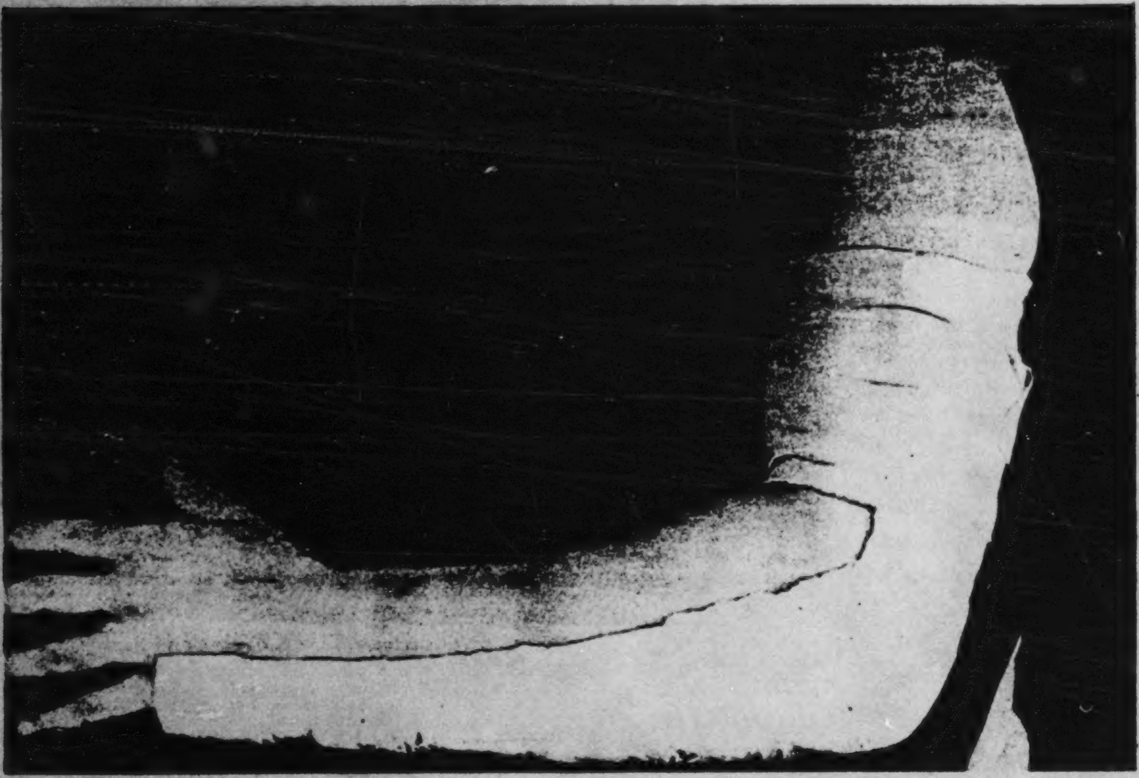

Figure 72. Long arm splint.

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LOWER LIMB CASTS

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143. Long Leg Cast

The long leg cast extends from the web of the toes upward to about 4 inches from the pubic area (fig. 73).

a. The cast should be applied with the foot in a natural position, the ankle at 90 degrees, and the knee in 0–15 degrees of flexion. While one operator applies the cast, another holds the foot with the toes in slight flexion at the metatarsophalangeal joints. The holder places his thumb on the dorsum between the first and second metatarsal heads and his fingers on the sole of the foot.

b. Cotton wadding is wrapped around the toes and continued up around the foot and ankle and from the ankle to the proximal part of the thigh.

c. The knee and the malleoli should be padded with felt.

d. Four 6-inch rolls of plaster bandage are applied. The plaster is rolled starting at the toes in about six turns and continued up around the foot and ankle and from the ankle to the proximal part of the thigh. As the plaster bandage is applied, it is smoothed and molded.

e. A short wide splint is placed over the sole and the heel, and a long wide one is applied anteriorly and centered over the knee. Both are tied in with plaster bandage.

f. Before the plaster is set, the limb is alined.

g. The cast is trimmed over the dorsum of the toes, and the rough edges are smoothed with a single layer of narrow plaster splint.

h. The long leg cast can be converted into a walking cast by attaching a rubber walking heel to the sole of the cast. About eight thick-

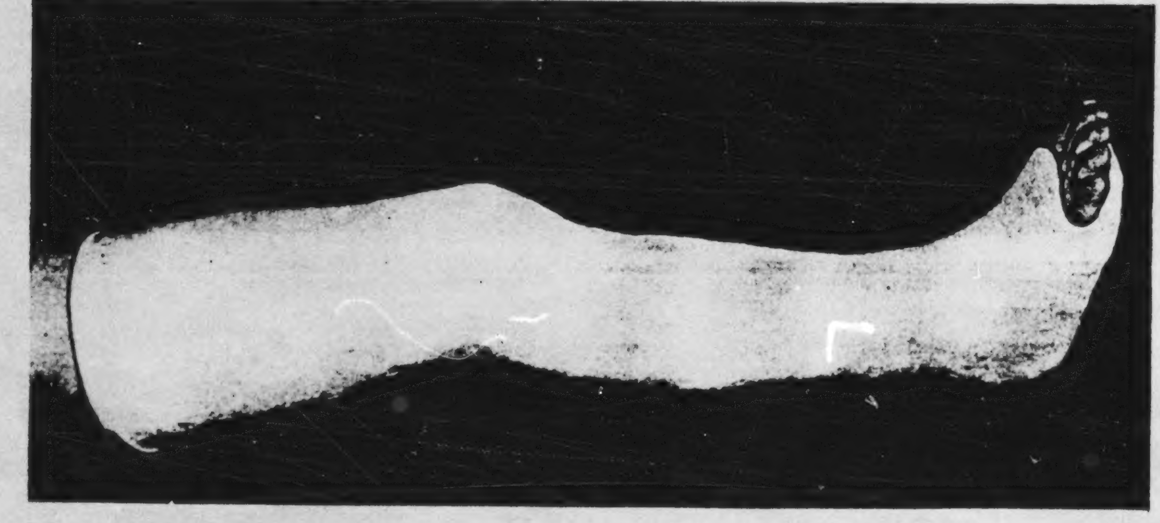

Figure 73. Long leg cast.

nesses of short plaster splint, 3 by 15 inches, folded twice, can be used as a foundation between the plaster and the heel. The foundation is attached to the cast, and the heel is placed on the foundation and tied in with the plaster bandage.

144. Long Leg Splint

This splint extends from the tip of the toes, down the sole of the foot, up the posterior side of the leg, and to the proximal end of the thigh (fig. 74).

a. The foot should be in a natural position, the ankle at a 90-degree angle, and the knee at about 15 degrees.

b. A splint of about 15 to 20 thicknesses is applied and held in place with 4- or 6-inch elastic bandages.

c. Air should be allowed to circulate around the leg while the plaster is setting, since sometimes the splint may generate more heat than the patient can tolerate.

145. Short Leg Cast

The short leg cast is applied the same as the long leg cast except that it ends below the knee (fig. 75).

a. The short leg cast usually extends from the web of the toes upward to 3 inches from the bend of the knee. In toe fractures it must begin at the tip of the toes for protection.

b. The ankle should be at a 90-degree angle with the foot in a natural position.

c. The cast should be trimmed to the web of the toes on top, and the margin of the toes if a footplate is desired.

d. Circulation should be checked.

e. The short leg cast can be converted into a walking cast by following the procedure described for the long leg cast (para 143*h*.)

146. Short Leg Splint

a. This splint is placed on the posterior side of the limb and extended from the tip of the

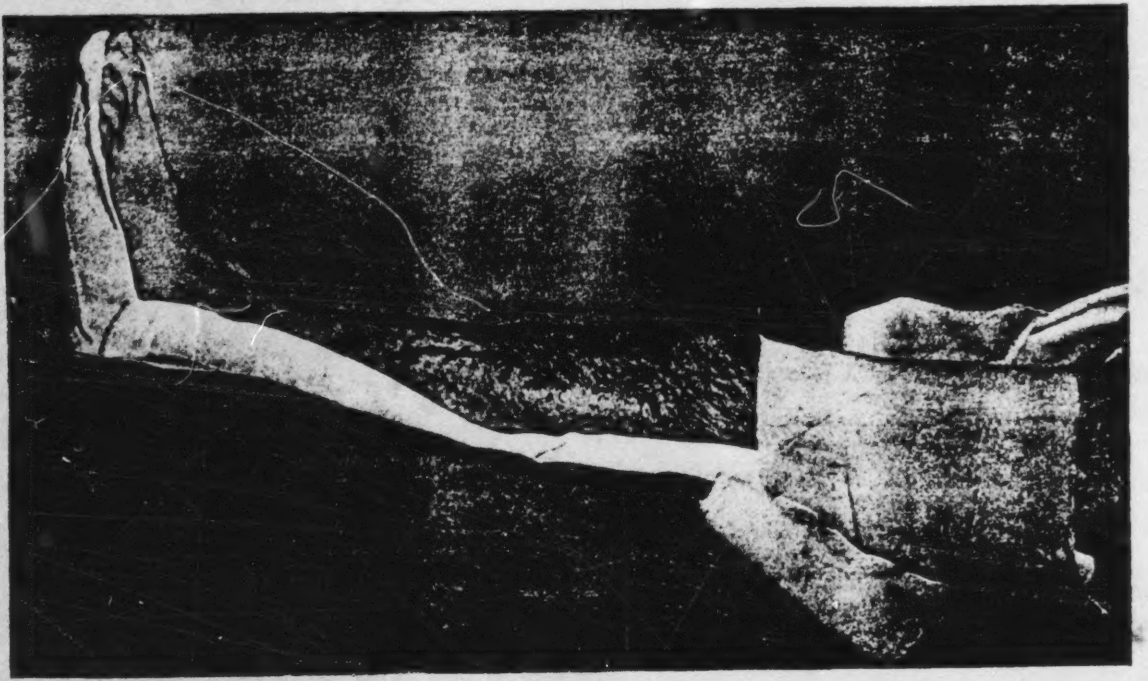

Figure 74. Long leg splint.

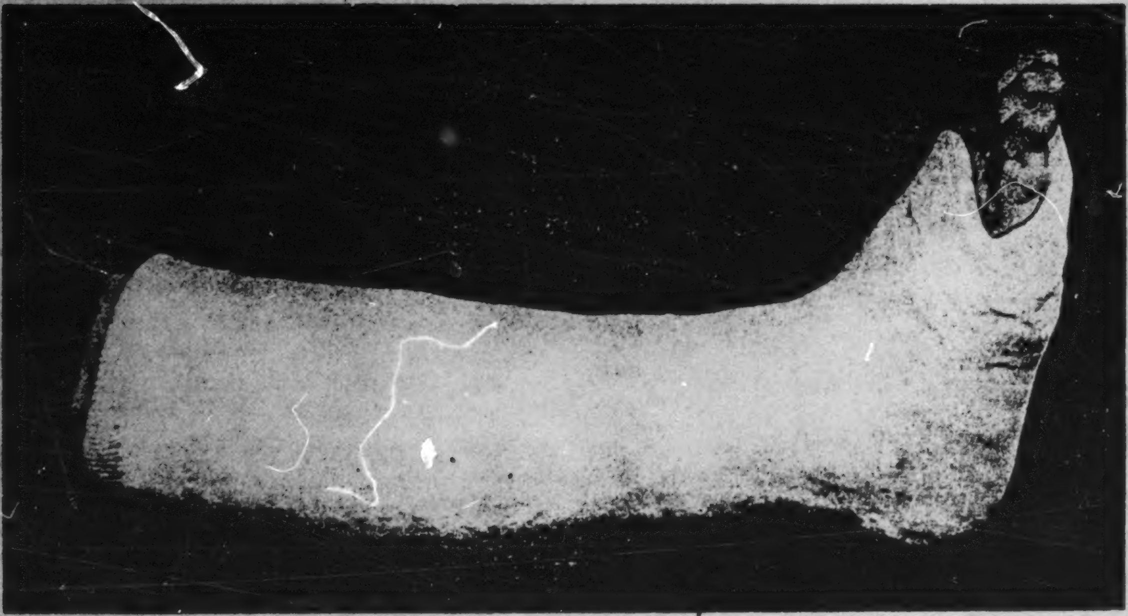

Figure 75. Short leg cast.

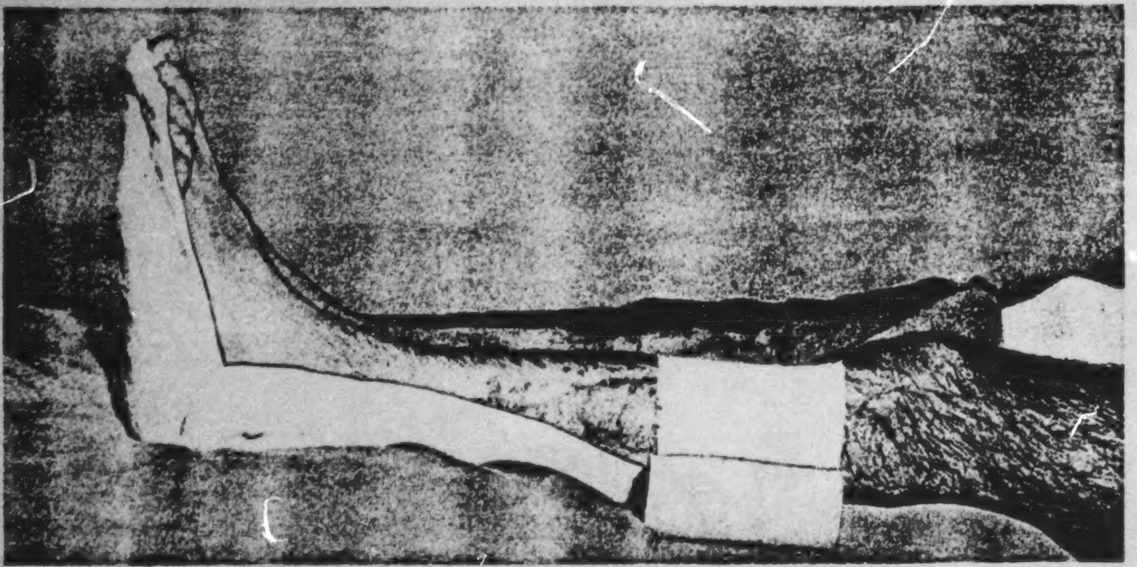

Figure 76. Short leg splint.

toes upward to 3 inches from the popliteal region on the knee with the foot kept positioned at a 90-degree angle (fig. 76).

b. The heel is padded well and a splint of approximately 15 layers is applied. The splint is held in place with an elastic bandage.

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c. Air should be allowed to circulate around the splint while the plaster is setting, since sometimes the splint may generate more heat than the patient can tolerate.

147. Long Leg Cylinder Cast

The long cylinder is similar to the long leg cast except that it ends about 3 inches above the ankle (fig. 77).

a. To prevent the cylinder from slipping, the leg is first painted with tincture of benzoin from ankle to knee so that the stockinet will stick to the skin.

b. Suitable sized stockinet is rolled on the leg from the ankle up.

c. Felt pads are placed in position, one around the ankle, one around the groin, and one over the knee.

d. Plaster bandage is then applied from the ankle to the groin.

e. Two long wide splints are applied, one anteriorly and one posteriorly, and tied in with plaster bandage.

f. After the second layer of plaster is applied, the edges of stockinet at both ends are folded over and secured with plaster splint or plaster bandage.

148. Cast for the Varus Foot

The varus foot bends inward, or toward the midline of the body. This is in contrast to the valgus foot, which bends outward or away from the midline. The purpose of a cast for the varus foot is to bring the foot toward the valgus position, or adduction.

a. In applying this cast, the cotton wadding and the plaster roll should be started with the roll held in the hand corresponding to the side on which the cast is being applied.

b. Each turn as it is brought under the plantar area of the foot should pull the foot into the valgus position, or adduction.

149. Cast for the Valgus Foot

The purpose of a cast for the valgus foot is to bring the foot toward the varus position, or adduction.

a. In applying this cast, the sheet cotton

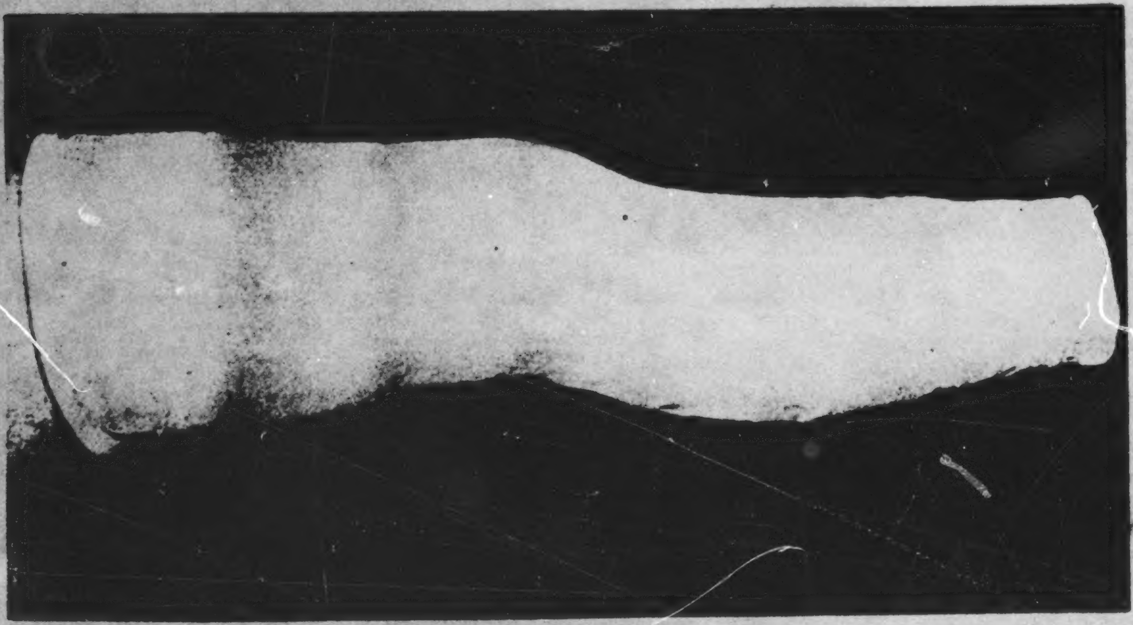

Figure 77. Long leg cylinder cast.

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and the plaster roll should be started with the roll in the hand opposite to the side on which the plaster is being applied.

b. Each turn of the cotton wadding and the plaster roll as it is brought under the plantar area of the foot should be pulled into the varus position, or adduction, and should elevate the longitudinal arch.

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CHAPTER 12

CERVICAL AND TORSO TYPE CASTS

150. Cervical Collars

The following procedure describes one of the many ways to immobilize the neck with a collar.

a. A piece of felt, ¼-inch thick, is cut in the length necessary to encircle the neck. It is shaped to fit the neck.

b. About five thicknesses of plaster splint,

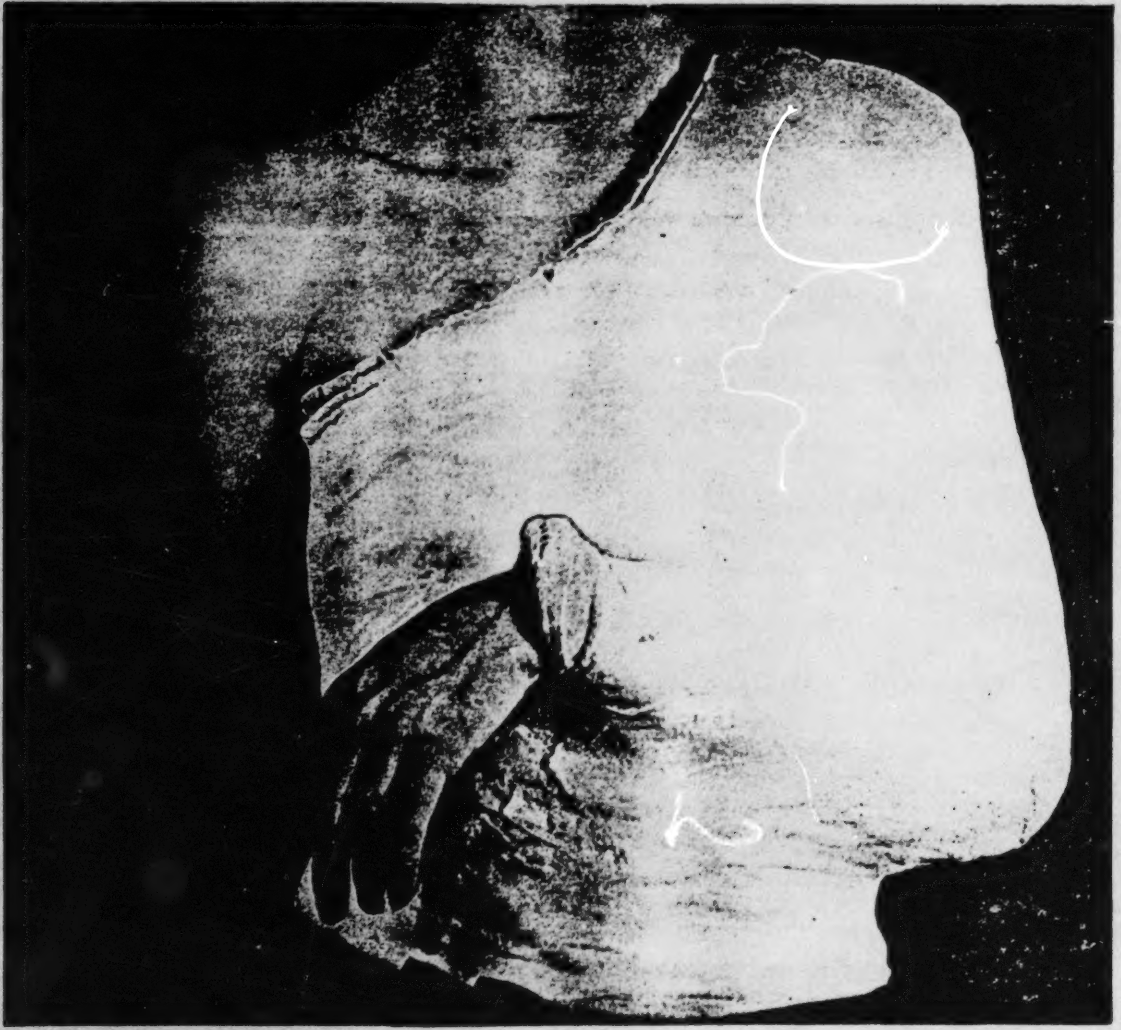

Figure 78. Velpeau cast.

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4 to 6 inches in width, are cut in the same length and shaped to fit the felt.

c. The splint is dipped in water and the excess water removed.

d. The splint and felt are placed together. Both are placed around the neck and molded under the chin, in the angles of the mandible, and over the shoulders.

e. A 4-inch plaster roll is then wrapped around the neck to tie in the felt and plaster splint.

151. Velpeau Cast

a. The patient slips into stockinet, 10 by 24 inches. The stockinet is rolled from the waist up and split under each arm. It is then pulled over the injured shoulder and secured with adhesive tape.

b. Pads are placed in the axilla and under the elbow.

c. The area is wrapped with cotton wadding.

d. The hand and arm of the injured side should be positioned, so as to be pointed in the direction of the opposite shoulder.

e. The weight-bearing shoulder and the crest of the ilium are padded.

f. Three 6-inch rolls of plaster bandage are rolled on (fig. 78).

152. Shoulder Spica Cast

In applying the shoulder spica cast, the arm is cast in the position ordered by the physician, usually away from the body (fig. 79). The lower part of the cast rests on the crests of the ilia.

a. When applied in a *sitting position*, the cast is applied as is the Velpeau except that the arm is extended in the position ordered by the physician and a brace or stick is added for support to the arm. It may be necessary to cut a window in the area of the axilla.

b. When applied in the *supine position* on the spica table, the following procedure may be followed:

(1) The patient lies on the spica backrest over which felt has been placed.

(2) Stockinet is applied to the trunk and the arm on the side to which the shoulder spica is to be applied.

(3) The trunk and arm are wrapped in cotton wadding, felt pads placed in position, and plaster bandage applied.

(4) A long, wide plaster splint is applied laterally on the trunk, extending up under the axilla and the arm; a second is placed posteriorly under the arm and shoulder across to the opposite side; and a third is placed over the shoulder with the ends drawn down anteriorly and posteriorly.

(5) The splints are tied in with plaster rolls, and the forearm and hand parts are completed.

(6) A strut is attached, joining the arm and trunk.

(7) When the plaster has set, the patient is turned on his side and the spica backrest is removed.

(8) A window may be cut in the area of the axilla.

153. Figure-of-Eight Cast

a. For children up to 6 years of age, felt inside of 2- or 3-inch stockinet applied as a figure of eight, secured in back with safety pins, and covered with 1-inch adhesive tape is sufficient to hold most clavicle fractures in place.

b. (1) For adults the same procedure is used but larger stockinet and felt are used, and 3- to 4-inch plaster rolls are used instead of adhesive tape to secure the figure of eight (fig. 80).

(2) When applying this cast the patient should sit erect on a stool with hands on hips and the thumbs touching in back, to prevent circulatory and nerve impairment. He must retain this position until the application is finished and the plaster has set.

(3) He should be instructed to sleep on his back with a pillow under each arm. When dressing he should insert the arm on the injured side into the garmet first.

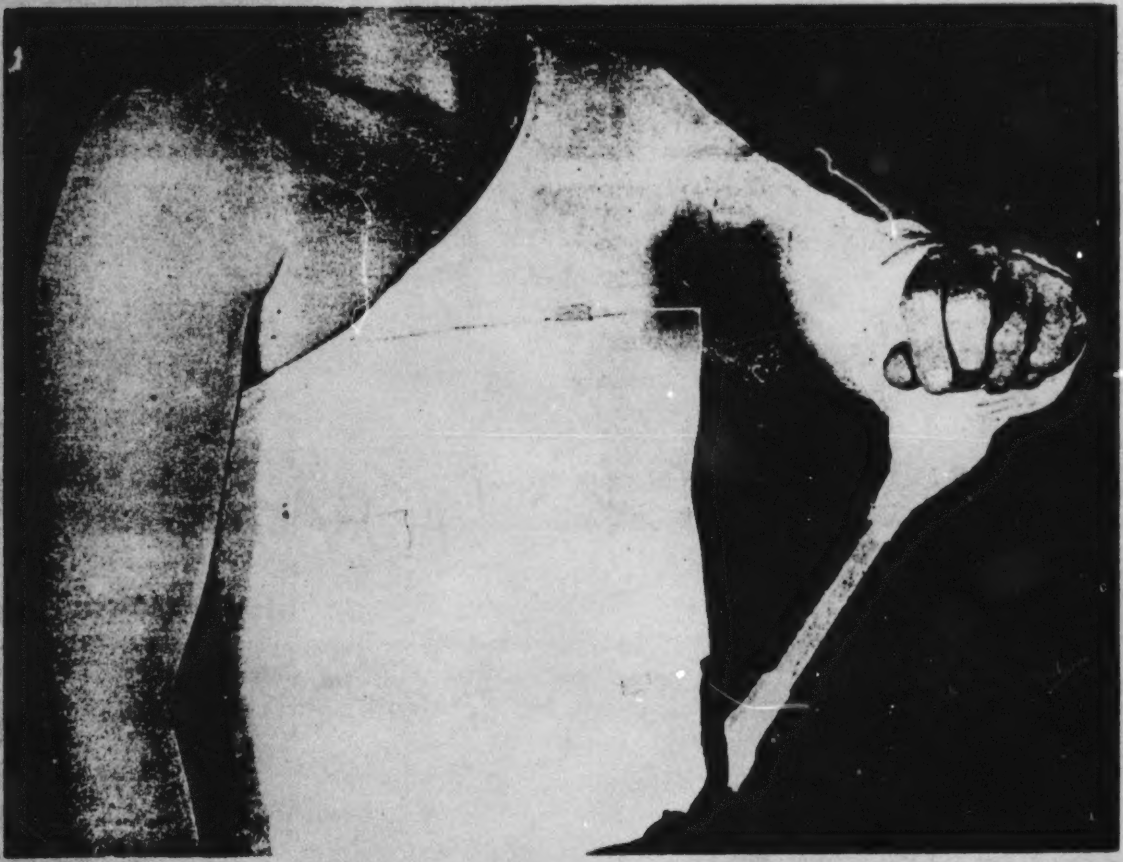

Figure 79. Shoulder spica cast.

154. Hip Spica Cast

The hip spica cast is one which includes the trunk, one hip, and one leg (single); the trunk, hips, one thigh, and one leg (one and one half) (fig. 81) or the trunk, hips, and both legs (double). The following procedure describes the application of the single hip spica cast. In this procedure, plaster is first applied to the trunk and hip as far as the supracondylar area of the knee, then to the leg, and last to the foot and ankle. To apply this type of cast the patient must be placed on an orthopedic table.

a. A pattern is cut from stockinet, stitched, and placed on the patient.

b. The perineal post of the table is padded and the patient is placed in position with the perineum placed against the perineal post. The legs are supported in the foot pieces of the table.

c. Cotton wadding is applied from the sternal notch to the ankle.

d. Felt pads are placed in position, directly under the plaster, and all surfaces where the bone lies close to the skin are padded.

e. The trunk and hip are wrapped with plaster bandage.

f. Splints are applied around the trunk from the very edge of the perineal post to the nipple line.

g. Circulation should be checked.

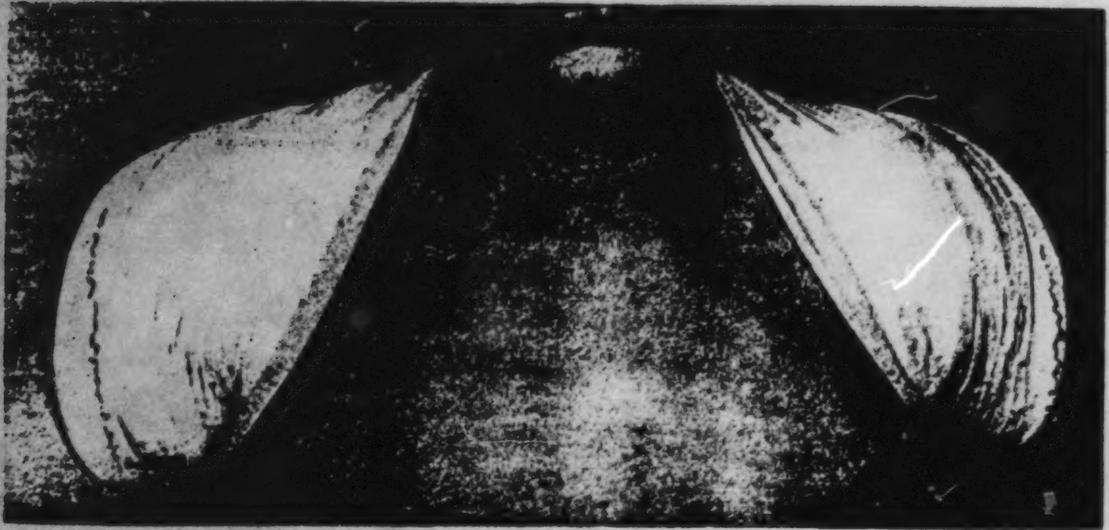

Figure 80. Figure-of-eight cast.

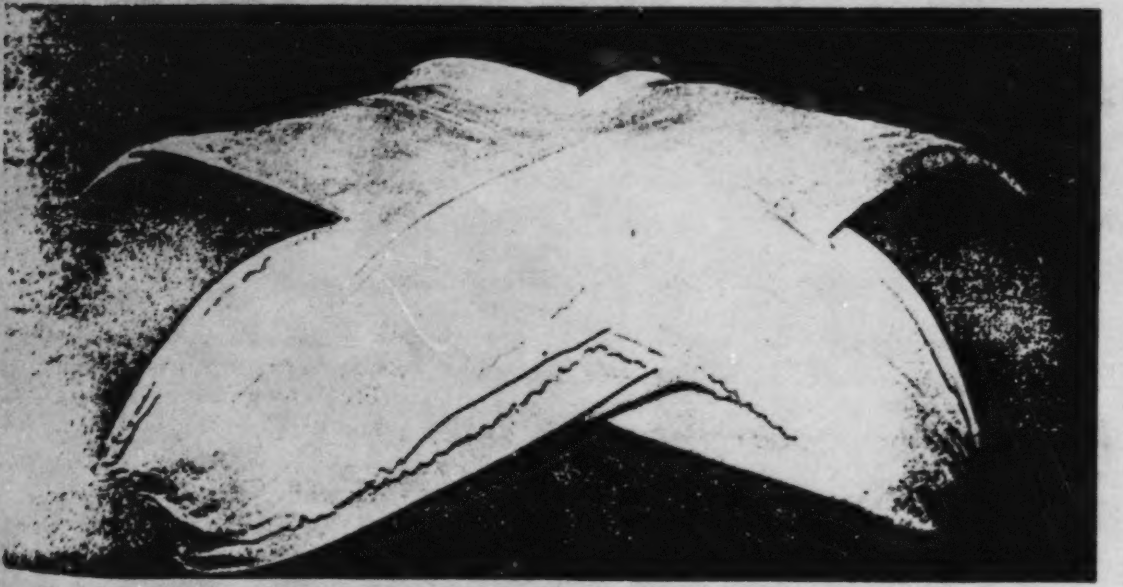

Figure 80—Continued.

h. Splints are applied to the hip, one poste-rly next to the post under the sacral seat, laterally, and one around the groin. The terior splint must be placed *next* to the post under the sacral seat to avoid weakness in this part of the cast.

i. The splints are tied in with plaster bandage.

j. While the plaster is setting, it is molded around the iliac crests and spines. As the trunk and hip parts set, the leg is incorporated into the plaster. As the leg part sets, the knee is placed in the proper position, and the foot and ankle are incorporated into the plaster.

k. The single hip spica cast can be converted into a walking cast by following the procedure described for the long leg walking cast (para 143*h*).

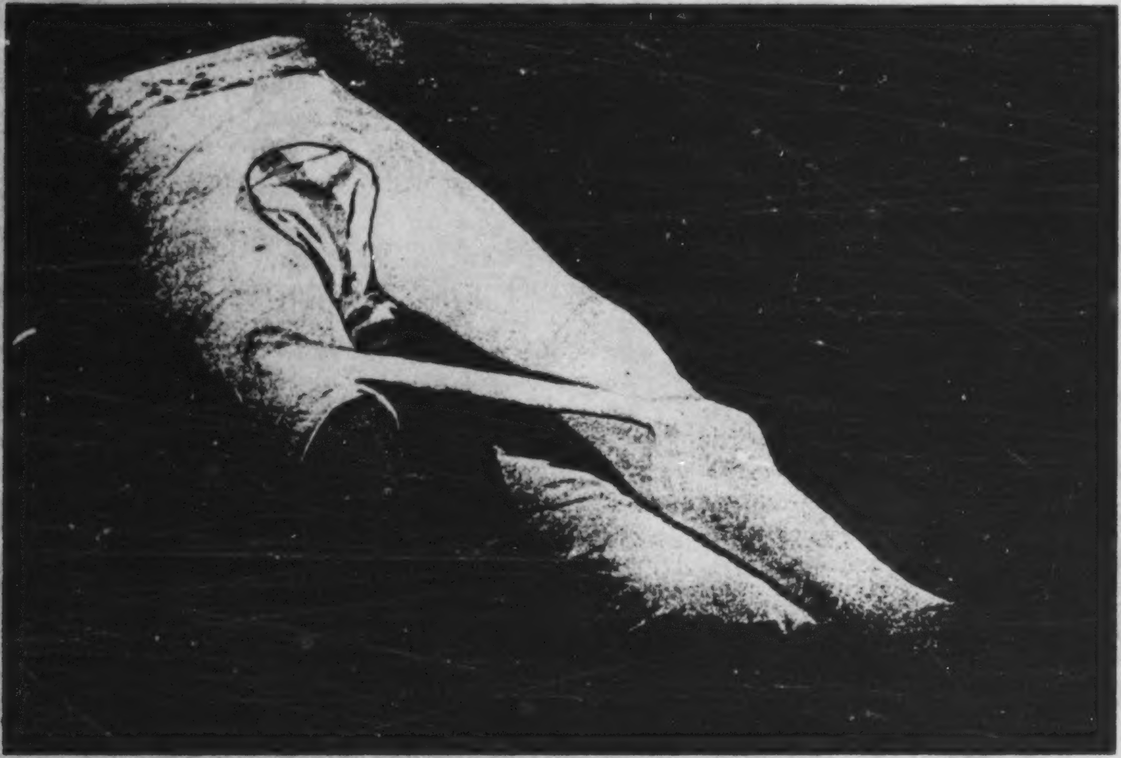

Figure 81. Hip spica cast, one and one half.

155. Frogleg Cast for Congenital Dislocation of the Hip

The perineal post of the portable spica box is padded with cotton wadding and the spinous processes are padded with felt.

a. The patient is placed on the sacral seat with the perineum resting against the perineal post, and is held in the desired frogleg position as dictated by the physician.

b. The legs and trunk are wrapped with cotton wadding, and felt pieces are placed in position.

c. The legs and trunk are wrapped with plaster bandage.

d. A long, wide plaster splint is applied across the hips posteriorly and pulled up to cover the hips anteriorly.

e. Short, wide splints are applied, one around each groin and one laterally on each side of the trunk and hip, and the plaster is allowed to set.

f. The feet are incorporated in the plaster.

g. The plaster is trimmed away from the genitalia and buttocks and toes.

156. Calot Jacket

The Calot jacket immobilites the neck and trunk, and sometimes the entire pelvis. It extends from the chin to the symphysis anteriorly, and from the occiput to the tip of the sacrum posteriorly. Two operators are needed to apply the Calot jacket, since the head and the trunk parts must be applied and molded at the same time.

a. Pattern. A pattern is cut from a length of stockinet. A semicircle is cut from each side of the stockinet where the neck is to fit, the edges of each semicircle stitched, and the pattern placed on the patient.

b. Position. The patient is placed over a felt pad on the Albee-Compere table. The perineum rests against the perineal post.

c. Traction. Traction is applied to the lower limbs and to the head. This is done to stabilize the patient while the plaster is being applied, or to produce distraction of the spine.

(1) The ankles are padded with felt, webbing cuffs buckled around them, and webbing straps inserted into the ratchets.

(2) A felt pad is placed under the chin. A muslin head halter is applied and secured with a narrow gauze bandage around the chin and occipital pieces at the level of the ear. The ends are attached to the ratchets.

d. Head and Neck.

(1) The head and neck are wrapped with 3-inch cotton wadding, and a roll of plaster bandage is applied, including the occipital rest.

(2) Short narrow splints are applied, one each around the chin, the neck, and the occiput, and another from the chin to the sternum. A long wide splint is applied from the perineal post to the occiput and is doubled over. Another splint is applied from the chin to the chest.

(3) The splints are secured with plaster bandage.

(4) Long wide splints are brought over each shoulder, and down on the chest.

(5) The plaster is then molded. It *must* be well molded under the chin and and the angles of the mandible.

(6) After the plaster has set, the halter is removed, excess plaster is trimmed from around the ears, and excess stockinet is trimmed away (leaving about 1 inch as overlap) and secured about 1½ inch as overlap) and secured with short narrow splints.

e. Body.

(1) Cotton wadding is applied around the torso, and felt pads are put in place, one in each groin.

(2) A thickness of rolled plaster bandage is applied.

(3) Three or four extra long, wide splints are placed around the trunk with the lowest splint against the perineal post. An extra long splint is placed laterally on each side.

(4) On each side a long wide splint is applied under and over each shoulder, and then pulled down in front. For additional support a V-shaped splint is applied over the shoulders with the point of the V between the scapulae and the ends over the shoulders. An extra long, wide splint is applied posteriorly from the perineal post to the occiput.

(5) The hips are covered as for a hip spica (para 154).

(6) The splints are tied in with plaster bandage, and the plaster is rubbed, molded, and allowed to set. The plaster must be well molded over the iliac crests and anterior superior iliac spines.

(7) Excess plaster around the perineal post and seat is cut away from the genitalia and buttocks and from under the axillae and over the shoulders.

(8) The patient is removed from the table, placed face down on pillows, and the head and sacral rests are removed from the plaster. Excess plaster is trimmed from the occipital part.

157. *Minerva Jacket*

a. The Minerva jacket is applied as is the Calot jacket, except that the head is included in the plaster (fig. 82). An additional plaster splint is placed around the forehead, and then the splints are wrapped in with 3-inch plaster bandage.

b. The weight of the cast should rest on the crests of the ilia and the shoulder—never on the patient's head. The patient should be able to open his mouth and feel comfortable around the throat.

c. This cast may have to be applied while the patient is on a Stryker frame in traction. If so, splints are applied on the anterior and posterior sides and then tied in with plaster bandage rolls. The traction is released when the plaster has set.

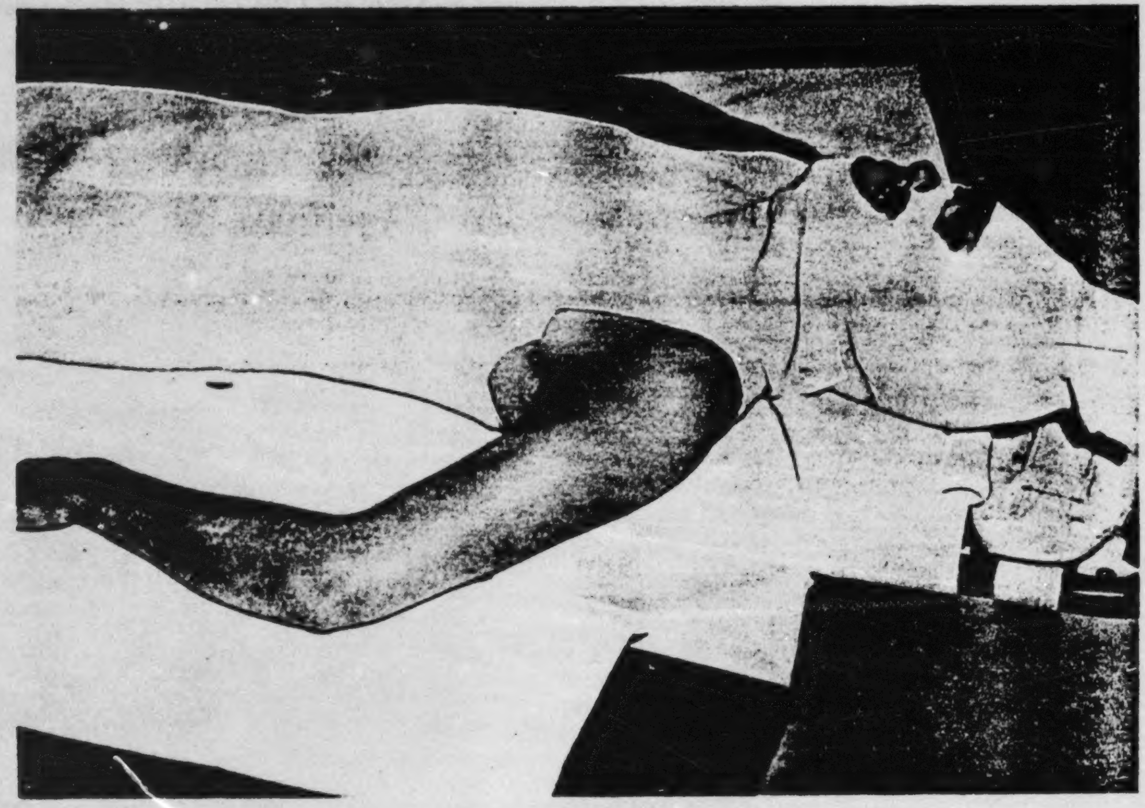

Figure 82. Minerva jacket.

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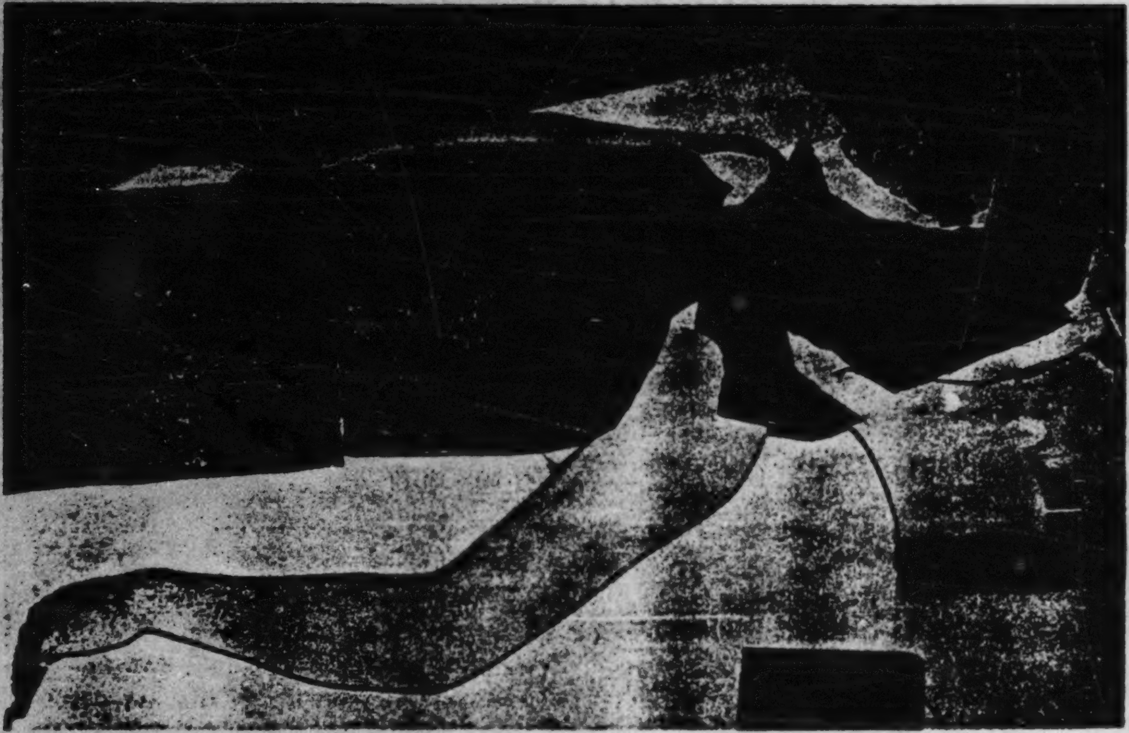

Figure 82—Continued.

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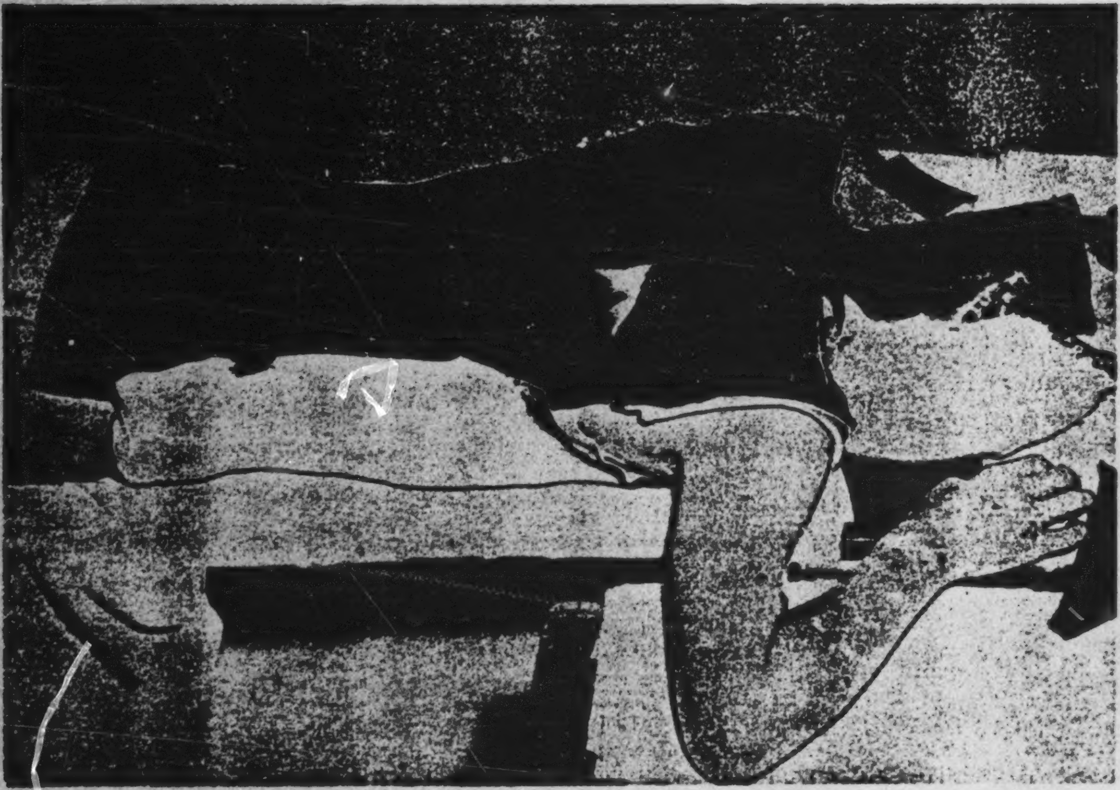
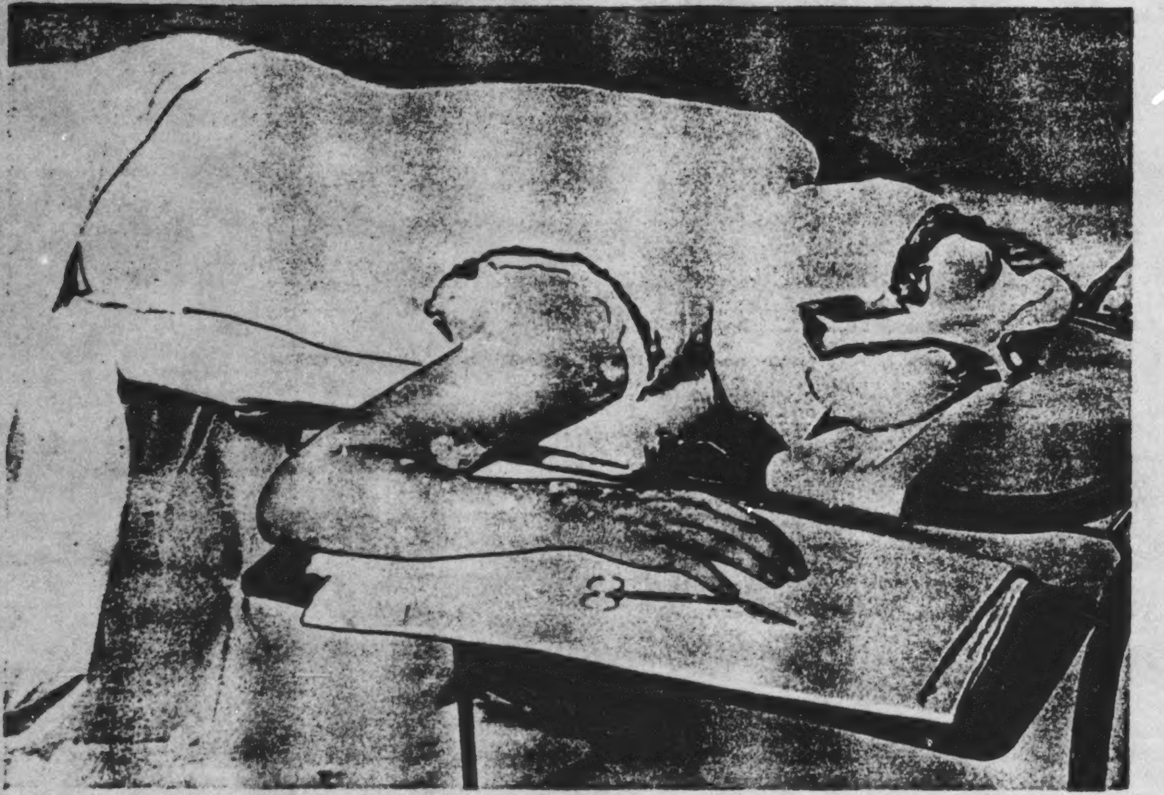


Figure 82—Continued.



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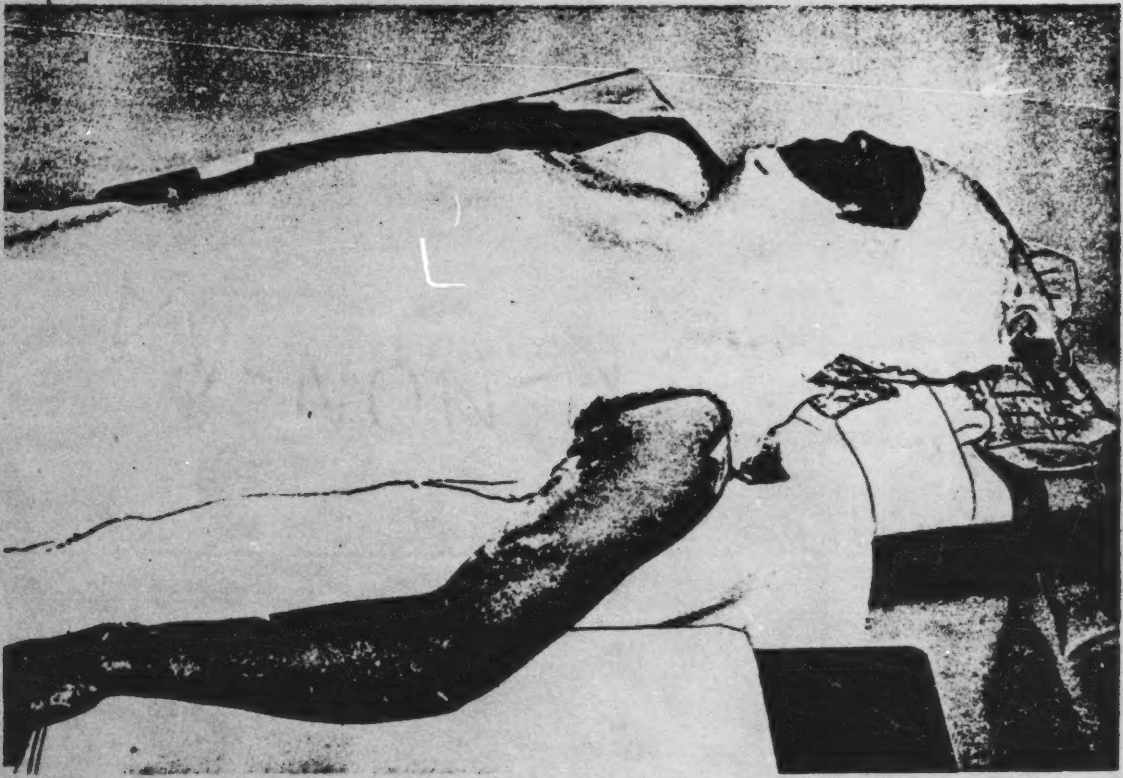

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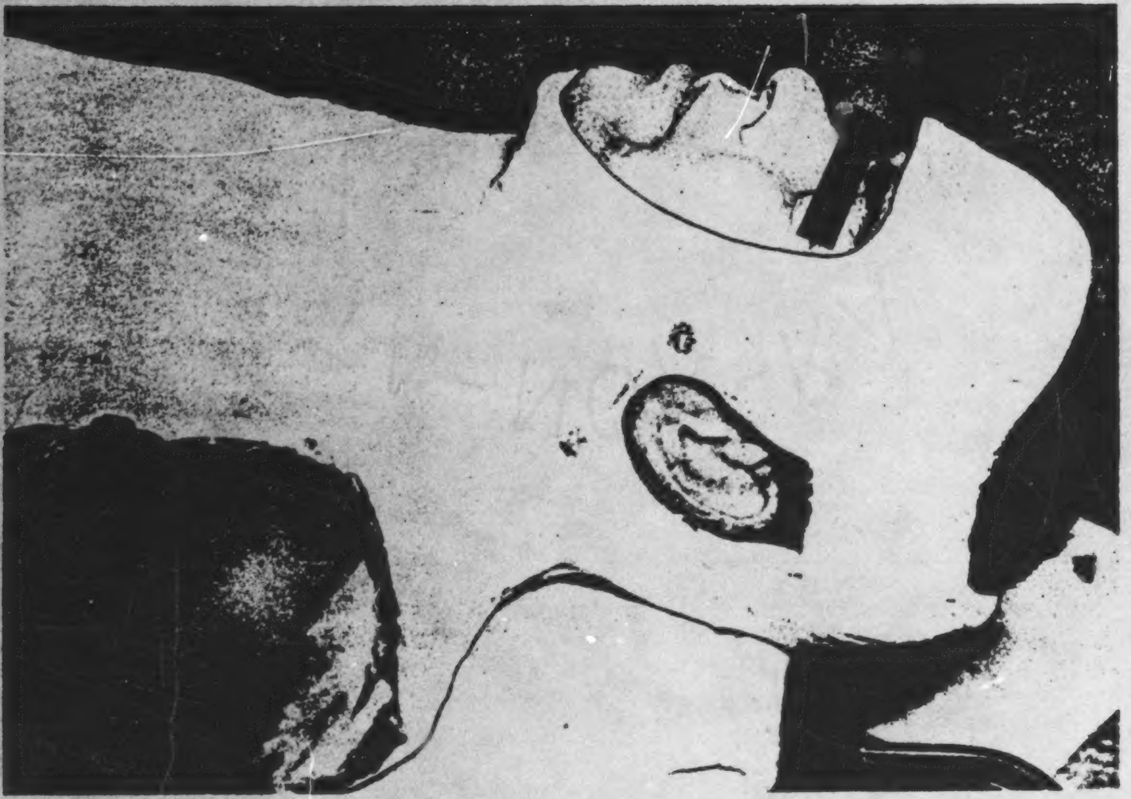

Figure 82—Continued.

CHAPTER 13

TRACTION TECHNIQUES

Section I. GENERAL

158. Objective in the Use of Traction

Traction is a technique which is used as an aid in reducing fractures and in relieving muscle spasm and pain. It is an exertion of pull which can be accomplished by means of traction apparatus, by manual means, or by a combination of the two. In this chapter, traction by the use of traction apparatus will be discussed. The objective in the use of traction for reducing fractures is to return the fragments of the fractured bone to their normal position and to restore and maintain the normal length and alinement of the bone. To maintain body alinement, countertraction (exertion of pull in the opposite direction) must be present. Continuous traction is often required.

159. Major Methods of Applying Traction

The major methods of applying traction are referred to as skin traction and skeletal traction. In these methods, traction is accomplished by the use of weights.

a. Skin Traction. In skin traction, adhesive material is applied to the skin and secured to the limb. The limb is then attached to traction apparatus and force is exerted. The limit of the weight used is 5 to 10 pounds. Skin traction is used chiefly for the relief of pain from muscle spasm and for correction of mild deformities.

b. Skeletal Traction. In skeletal traction, force is exerted directly on the bone of the limb by means of pins or wires which have been inserted through the bone and attached to traction apparatus. Skeletal traction is used chiefly in the reduction and maintenance of fractures of the lower limb. A greater pull can be exerted on the limb by skeletal traction than by skin traction. It is more effective in reducing fractures of long bones.

Section II. BASIC FORMS OF TRACTION APPARATUS AND TECHNIQUES IN APPLICATION

160. General

a. Traction is used in the treatment of affections of the spine, the upper limbs, and the lower limbs. There are several basic forms of apparatus which are used for this purpose. Most of the techniques used in the application of traction apparatus are based on the principle of a system of pulleys, weights, and cords. In a single-pulley system the exact force of the weight applied is transmitted to the affected part. The pulley changes the direction of the force. In the treatment of affections of the upper part of the spine, traction is applied to the head. When traction is desired on the lower part of the spine, it may be applied to the pelvic girdle or to the lower limbs. In balanced traction, the limb is suspended on a splint, and the system of pulleys, weights, and cords is used.

b. The procedures described in this chapter are representative of the types of procedures which might be used. They must not be considered as inflexible guidelines, since there may be local variations of the procedures, depending upon the preferences of the orthopedic surgeons.

161. Standard Procedure When Traction is To Be Applied

The orthopedic specialist must have a complete understanding of the physician's orders so that he can follow them carefully and accurately. He should not be reluctant to use a notebook when taking these orders.

a. The physician prescribes the traction weight and no modification of this weight is made unless it is ordered by the physician.

b. The orthopedic specialist should first consult the physician or nurse about the condition of the patient (physical and mental), and then assemble all equipment needed and clear the area of visitors.

c. He should introduce himself to the patient, explain the traction procedure, and perform his duties as quickly and as efficiently as possible.

d. After completing a traction procedure, he must report to the physician or nurse as soon as possible.

e. He must check traction apparatus daily. When bed rails are in use, he must make sure they are in place before leaving the room, if only for a short time.

f. It is mandatory when working on a female patient to have a female assistant present.

162. Orthopedic Beds and Frames
(fig. 83)

There are many different types of orthopedic beds and frames. Basically, they are the same, and can be set up for traction without difficulty.

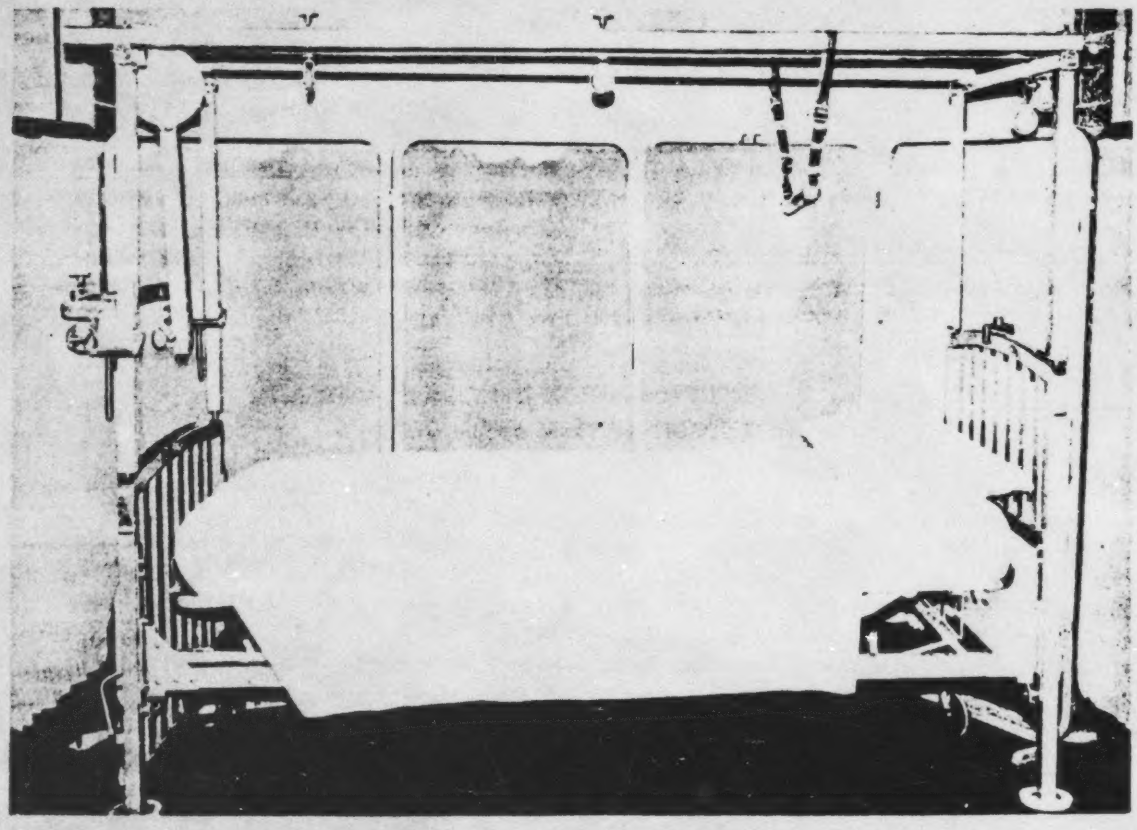

Figure 83. Orthopedic bed with Balken frame.

163. Skin Traction

a. Equipment. The equipment needed for skin traction is illustrated in figure 84. For preparing the patient, the necessary equipment includes the following:

(1) Sponge bowl, water, and soap.
(2) Razor and blades.
(3) Several dressing sponges, 4 by 4 inches.
(4) One hand towel.
(5) Covered rubber sheet.

b. Procedure (Nonsterile) for Preparing the Skin.

(1) A covered rubber sheet is placed under the area to be prepared and the area is moistened with gauze sponge.
(2) The area where adhesive is to be used is shaved.
(3) The area is dried and the covered rubber sheet is removed.

c. Points to Remember.

(1) If the physician prescribes over 5 pounds of traction, traction is started with 5 pounds for the first 2 hours, then weights are added to bring the weight to the prescribed total. Starting with more than 5 pounds may cause moleskin straps to slip.
(2) There are many deviations from the basic traction. After traction has been applied, it should not be changed without consulting the physician. He may have made some adjustments.
(3) The orthopedic specialist should be certain he is applying traction to the limb for which it has been prescribed (right or left). He should take his time, be gentle, do his best, and try to improve with each patient.
(4) Hand traction is retained when necessary (while applying skin traction).
(5) The orthopedic specialist should report to the physician or nurse when a procedure is to be repeated.

164. Skeletal Traction

a. Equipment for Skeletal Traction. The equipment for skeletal traction is illustrated in figure 85. The equipment for preparing the patient includes the following:

(1) Sponge bowl, water, and soap.
(2) Razor and blades.
(3) Several sponges, 4 by 8 inches.
(4) Container of Zephiran or alcohol.
(5) Antiseptic.
(6) Sterile towels.
(7) Light.
(8) Covered rubber sheet.
(9) Ring forceps (one sterile).
(10) Pair of sterile gloves.

b. Procedure for Preparing the Skin. Skin preparation consists of cleaning and shaving an area sufficiently large to provide ample field for an operation. The purpose of preparing the skin is to make the operative field as clean as possible.

(1) First, the hands are washed and a covered rubber sheet is placed under the area to be prepared.
(2) The light is placed at the best angle to see the hair to be shaved. A small area at a time is lathered with moistened gauze. The area should be shaved in the direction of hair growth and with care to avoid cutting the skin.
(3) The area is scrubbed for about 10 minutes and the skin dried carefully with sterile sponges and a sterile towel.
(4) The rubber sheet is replaced with a sterile towel and the sterile area covered with another sterile towel.
(5) The physician should be notified that the patient is ready.

c. Procedure To Be Completed Before Physician Arrives.

(1) The nurse should be notified before starting the procedure of preparing the patient.
(2) A check is made on the size of the gloves, the strength and name of the local anesthetic, where the procedure is to be done, and the area where the pin is to be inserted.

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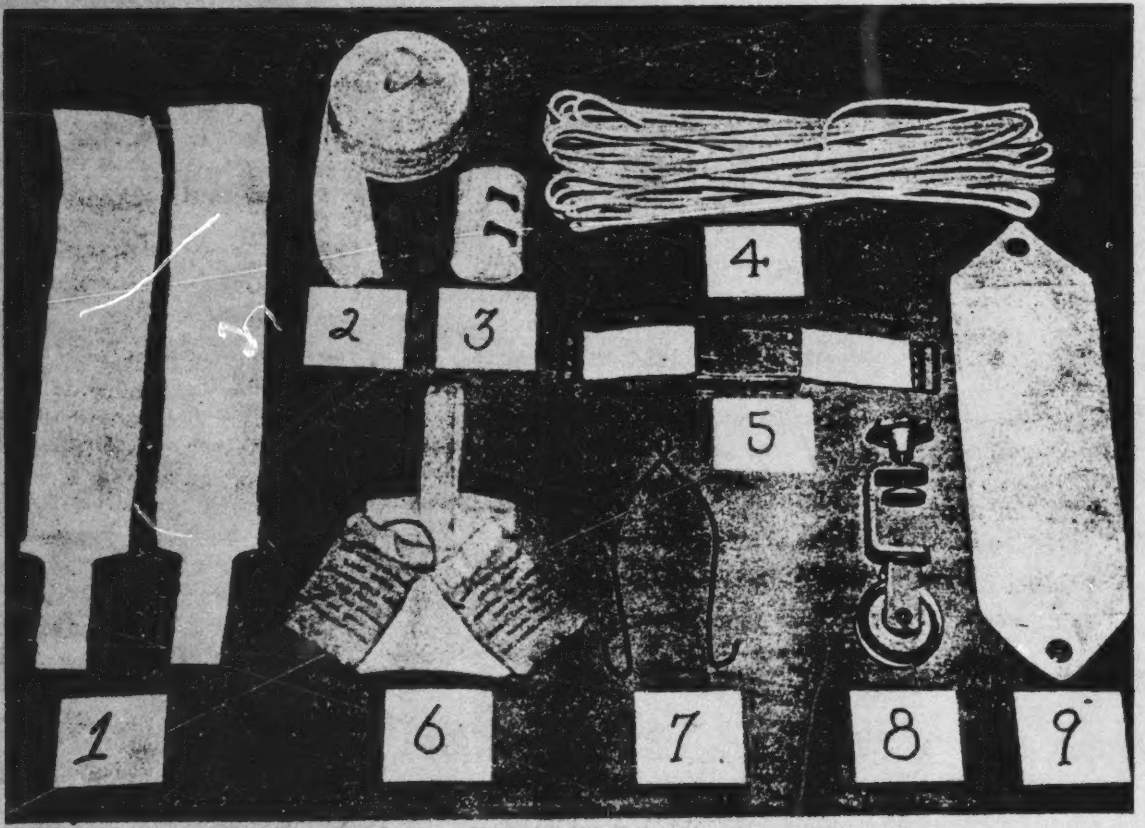


1. MOLESKIN STRAPS.
2. STOCKINET.
3. ELASTIC BANDAGE.
4. TRACTION ROPE.
5. SPREADER BLOCK.
6. SHOT BAG AND WEIGHTS.
7. YOKE.
8. PULLEYS.
9. CANVAS SLING.

Figure 84. Equipment for skin traction.

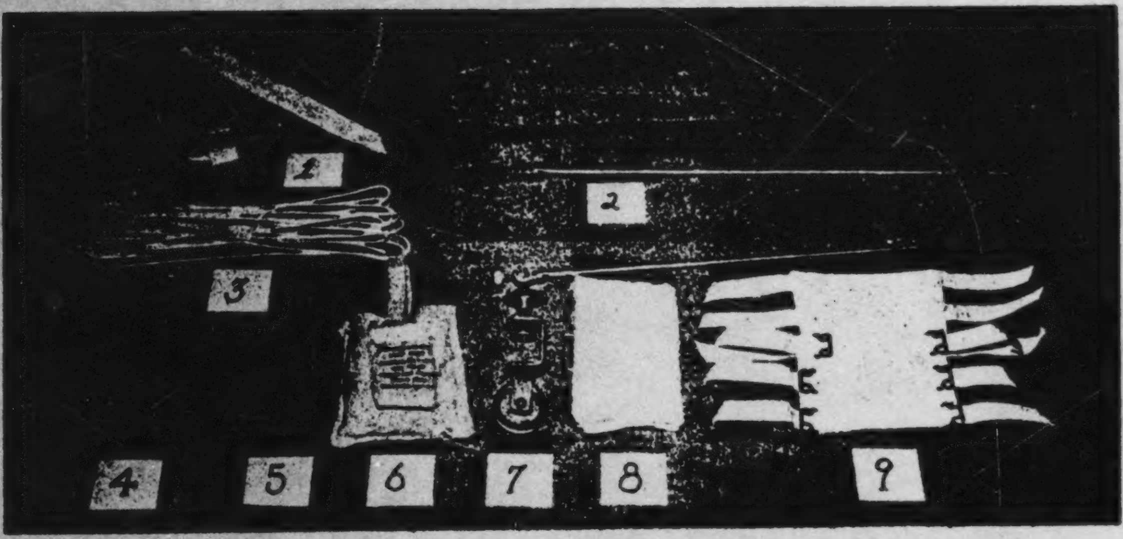
(3) All equipment needed for the procedure is assembled.

(4) The patient is prepared (sterile), and the sterile field is maintained.

(5) The pin set is placed on the Mayo stand (located near the working area), and alcohol sponges are placed on top of the procaine or whatever local anesthetic is to be used.

165. Standard Procedure After Traction (Skin or Skeletal) Has Been Applied

a. The orthopedic specialist should report to the physician or nurse when the procedure is completed.



1. THOMAS SPLINT.
2. PEARSON ATTACHMENT.
3. TRACTION ROPE.
4. STEINMANN PIN TRACTOR.
5. KIRSCHNER WIRE TRACTOR.
6. CANVAS BAG AND WEIGHT.
7. PULLEYS.
8. ABD PAD.
9. CANVAS SLINGS.

Figure 85. Equipment for skeletal traction.

b. He should make daily checks of the following:

(1) *Ropes,* to determine that they are not worn, that knots are secure, that ropes are not resting against each other, and that the ropes are resting in the pulleys.

(2) *Bandages and ABD pads,* to make sure that they are clean and dry, and that they are in the right place.

(3) *Weights,* to make sure that they are not resting on the floor or against the bed.

(4) *Patient,* that the body is in alinement with traction, that the feet are not against the foot of the bed in traction of lower limb, and that the head (in cervical traction) is not against the head of the bed.

(5) *Pulleys,* to make sure that the clamps are tight.

c. He should report to the nurse any unusual occurrences, such as the patient removing traction or parts of the traction.

d. He should not awaken the patient to apply or check traction.

e. Always when in doubt, he should check with the physician or nurse.

166. Right Angle Skin Traction
(fig. 86)

Right angle skin traction is used for some fractures of the elbow and for some fractures of the forearm.

a. Equipment.

(1) Sponge bowl, water, and soap.
(2) Sponges, 4 by 8 inches.
(3) Ace adherent and applicator.
(4) Two moleskin straps, 18 inches long.
(5) One piece of stockinet, 12 inches long.
(6) One 3-inch elastic bandage.
(7) One spreader block.
(8) Two pulleys.
(9) About 4 feet of traction rope.
(10) Two felt pads, 3 by 3 inches, ½ inch thick.
(11) One canvas sling or 4-inch stockinet, 14 feet long.
(12) Eleven small ABD pads.
(13) Orthopedic bed with overhead frame and extension bar.

b. Procedures.

(1) First, the standard procedure is checked.

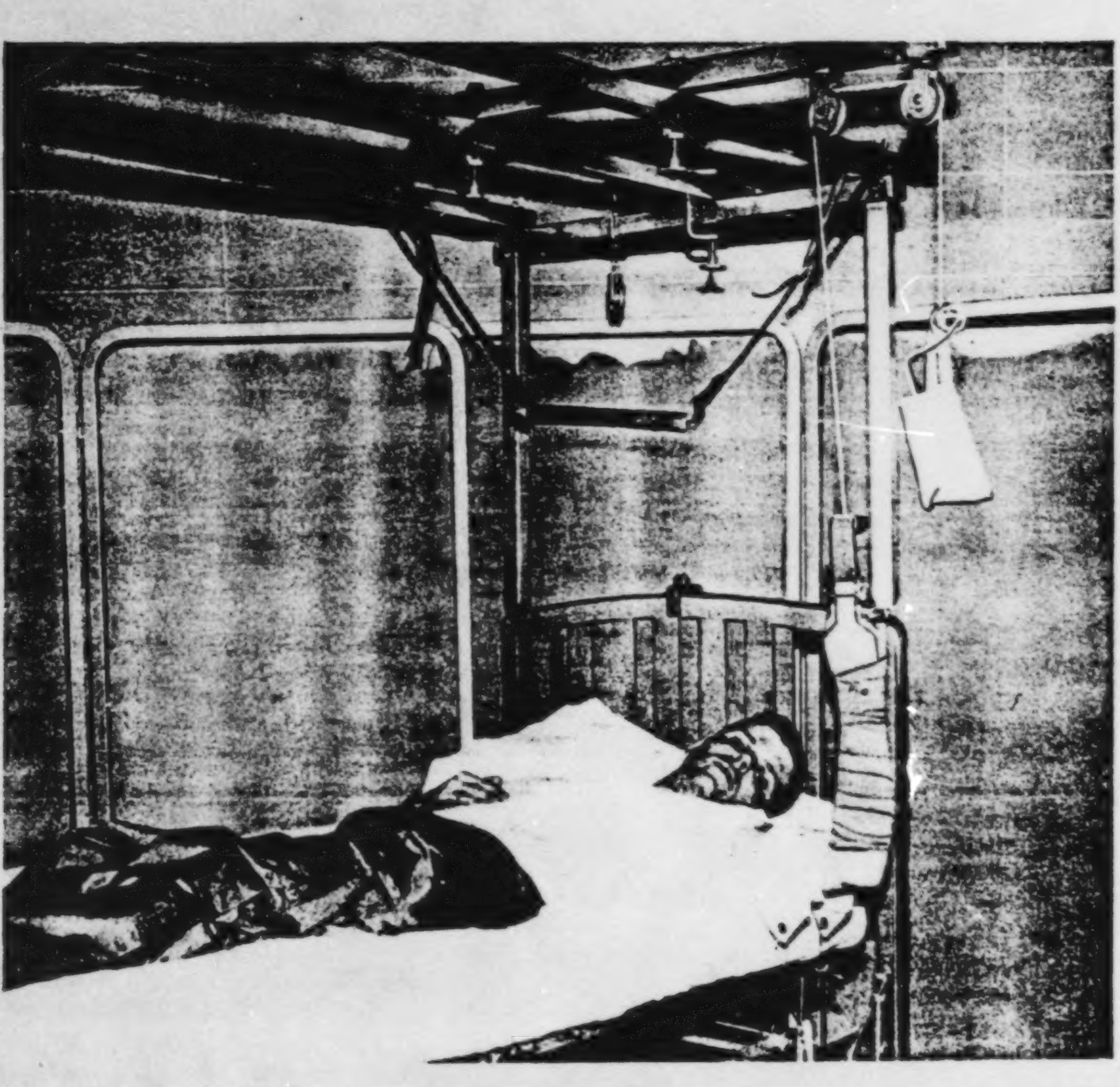


Figure 86. Right angle skin traction.

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(2) The limb is washed and prepared.
(3) Ace adherent, moleskin, stockinet, and spreader block are applied, with the spreader extending beyond the tips of the fingers.
(4) Rope is placed in the spreader with a simple knot. The rope is run through a pulley over the arm at the top of the frame, and then through another pulley to suspend the weight away from the patient.
(5) Weight (about 3 pounds) is added.
(6) The canvas sling is padded with an ABD pad, and placed over the biceps of the upper arm.
(7) The rope is attached to the canvas sling.
(8) The shot bag is secured to the sling, and the prescribed weights are added.
(9) The patient is alined to traction and made comfortable.

167. Right Angle Skeletal Traction
(fig. 87)

Right angle skeletal traction may be used for Colle's fractures of the wrist and for some fractures of the ulna and radius.

a. Equipment.
(1) Sterile preparation tray.
(2) Two pairs of sterile gloves (correct size).
(3) Two percent novocain.
(4) Sterile pin tray.
(5) Mayo stand.
(6) Canvas sling.
(7) Two small ABD pads.
(8) Two shot bags.
(9) Ace adherent and applicator.
(10) Traction rope.
(11) Two pulleys.
(12) Two S-hooks.
(13) Orthopedic bed with overhead frame.

b. Procedure.
(1) The area where the pin is to be inserted is prepared and covered with a sterile towel.
(2) The orthopedic specialist assists the physician with gloves after he scrubs. He opens the pin set, directs the light on the operative sight, and continues to assist the physician, following his orders and instructions accurately.
(3) When the procedure is completed, the ends of the wire and cork are cut, and the yoke is placed on the pin and tightened.
(4) The rope is secured to the S-hook, the S-hook is placed in the desired hole in the yoke, and the rope is run through the pulley on the overhead frame.
(5) The rope is run through another pulley away from the patient, and is tied to the traction bag. Weights are added. The rope may be tied direct to the extension bar, with the elbow held at a 90-degree angle over the side of the bed.
(6) The canvas sling with ABD pad is placed over the biceps.
(7) The rope is attached to the canvas sling, the shot bag secured to the sling, and the prescribed weight added.
(8) The patient is then alined to traction and made comfortable.

168. Cervical Traction (Skin)
(fig. 88)

The canvas head halter is used for skin traction in the treatment of affections of the cervical spine, such as strain, injuries of the neck, and pinched nerves of the neck. The orthopedic specialist does not apply the head halter unless directed to do so by the physician.

a. Equipment.
(1) One head halter—large, medium, or small.
(2) One spreader bar—large, medium, or small.
(3) Two small ABD pads.
(4) Three feet of traction rope.
(5) One pulley or headboard bracket.
(6) One shot bag.
(7) Five or ten pounds of weight.
(8) Orthopedic bed with head bar.

b. Procedure.
(1) The pulley is placed in the center of the bar at the head of the bed.
(2) A simple knot is tied in the end of the rope and the rope is cut to the cor-

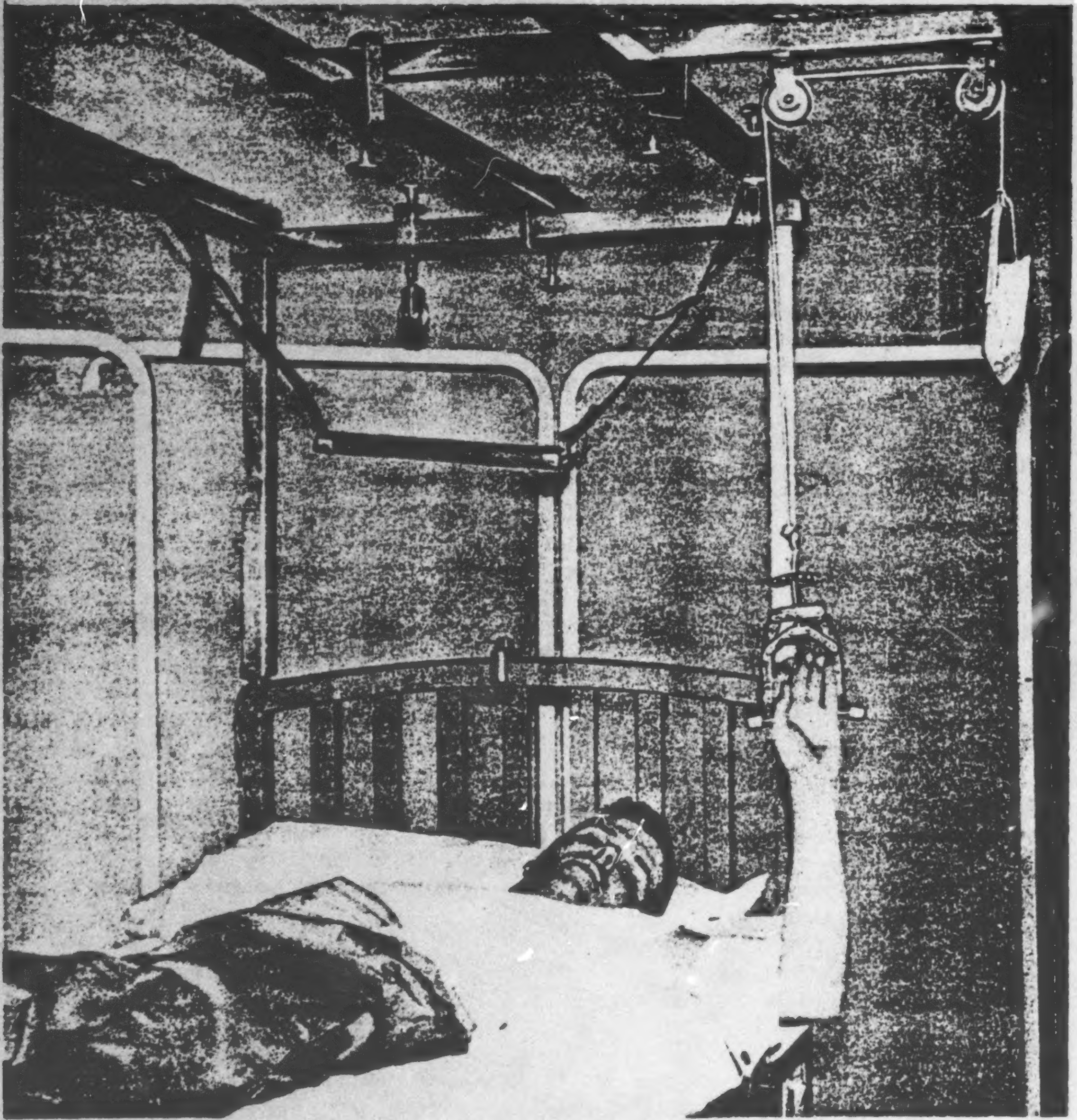

Figure 87. Right angle skeletal traction.

rect length. The bag is securely fastened to the rope.

(3) The canvas sling, with chin side up, is gently placed over the head of the patient.

(4) One folded small ABD pad, with soft side out, is placed under the chin and another under the back of the head between the sling.

(5) The side straps are adjusted to fit the

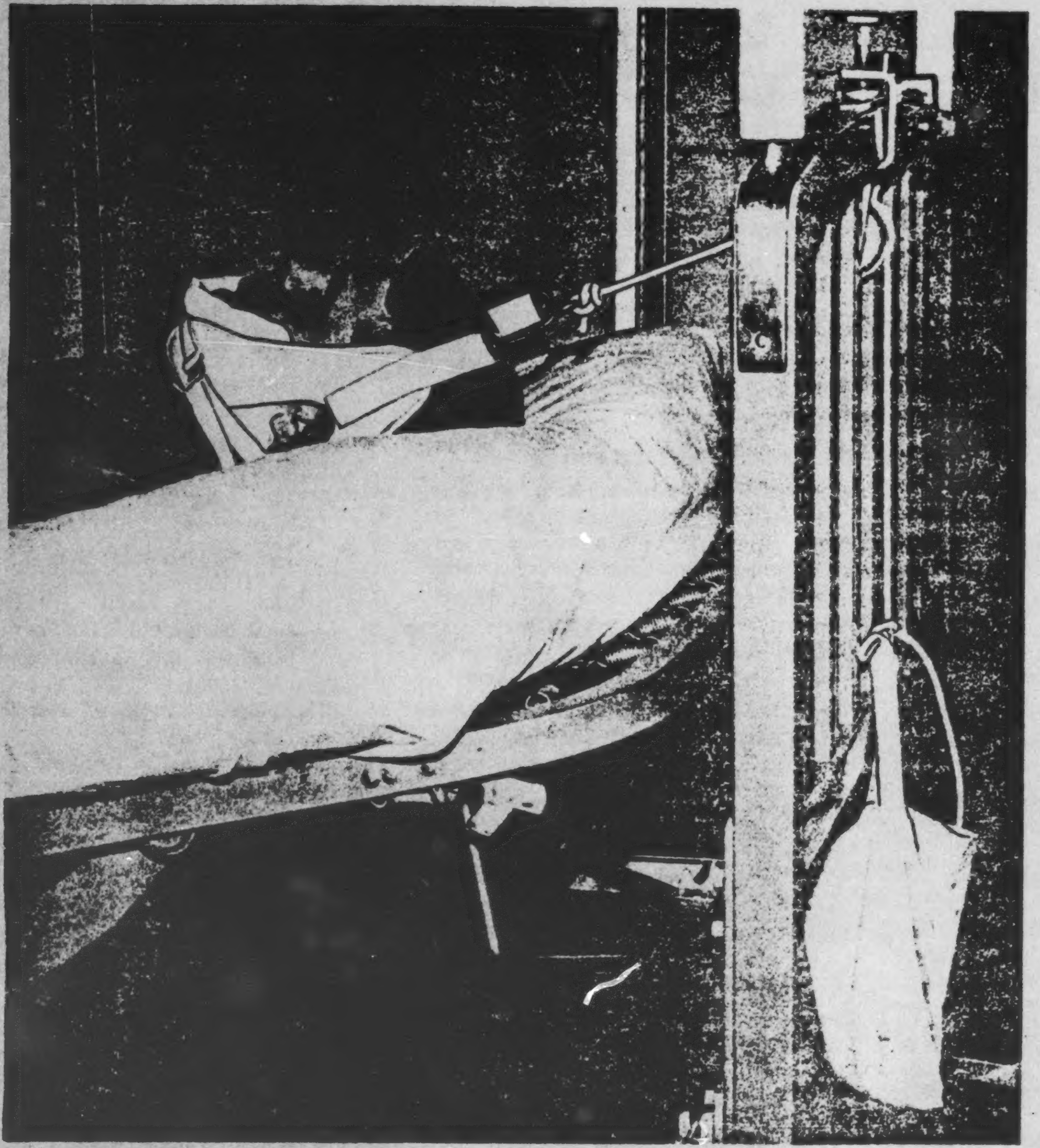

Figure 88. Cervical traction (skin).

patient's head.

(6) The spreader bar is placed in the rings at the end of the long straps.

(7) The bag is removed from the pulley and the slack is taken up on the rope until the full weight is extended on the head of the patient.

(8) The patient is alined in bed and the

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bed elevated several inches.

(9) Ear room is checked and a check is made to see if the chin strap is blocking the air passage in the neck.

(10) The specialist explains to the patient how to get in and out of his traction by removing the spreader bar at the end of the long straps. He observes the patient remove and replace the spreader bar.

(11) He explains to the patient that traction may be removed only by orders of the physician, and makes sure the patient is as comfortable as possible.

(12) He checks with the physician about the application of the head halter.

169. Cervical Traction (Skeletal)

Vinke or Crutchfield tongs are used for skeletal traction in the treatment of affections of the cervical spine. They are used almost exclusively for fractures or fracture-dislocations. The tongs are applied to the sides of the skull.

a. Surgery is responsible for the equipment needed for these operations. The operation is usually performed on a Foster frame.

b. The orthopedic specialist is responsible for the following equipment and for seeing that the nurse knows where this equipment is before the operation begins:

(1) Traction rope or cable.
(2) S-hook.
(3) Weight, 10 to 20 lbs.
(4) Holder to contain the weights.

170. Buck's Traction
(fig. 89)

Buck's extension is probably the most widely used form of traction apparatus. It is used in skin traction for the correction of mild contractures and relief of pain from muscle spasm. It is widely used for conditions of the knee, femur, or hip joint in which partial immobilization with light traction is required.

a. Equipment.

(1) Pan, soap, and water.
(2) Razor.
(3) Two moleskin straps.
(4) Stockinet, 8 inches long, 3 inches thick.
(5) Two felt pads, 3 by 3 inches, ½ inch thick.
(6) Elastic bandage, 3 and 4 inches.
(7) Spreader block.
(8) Traction rope, 3 feet.
(9) One pulley.
(10) Ace adherent and applicator.
(11) One pillow.
(12) One shot bag.
(13) Five or ten pounds of weight. (For bilateral Buck's traction, items listed in (1) through (13) should be doubled.)
(14) Orthopedic bed with foot bar or Buck's bar.

b. Procedure.

(1) The skin is cleaned with soap and water.

(2) The lower limb is prepared and hair is removed.

(3) The skin is dried and Ace adherent is applied.

(4) Moleskin is applied. Unless there is some contraindication due to sensitive skin, moleskin is applied directly to the skin.

(5) Felt pads are placed over the malleoli (ankle bone).

(6) Starting at the distal end of the limb, elastic bandage is wrapped on snugly to secure moleskin.

(7) The ends of the moleskin straps are secured to the buckles and the spreader block is placed as close to the foot as possible.

(8) Rope is run from the center of the spreader block as close to the foot as possible.

(9) The leg is placed on the pillow so the heel of the foot is free from the bed, and the end of the bed is cranked up a few inches.

(10) The patient is alined in relation to the traction and made as comfortable as possible.

171. Pelvic Traction
(fig. 90)

a. Equipment.

(1) Corset with straps and rings at-

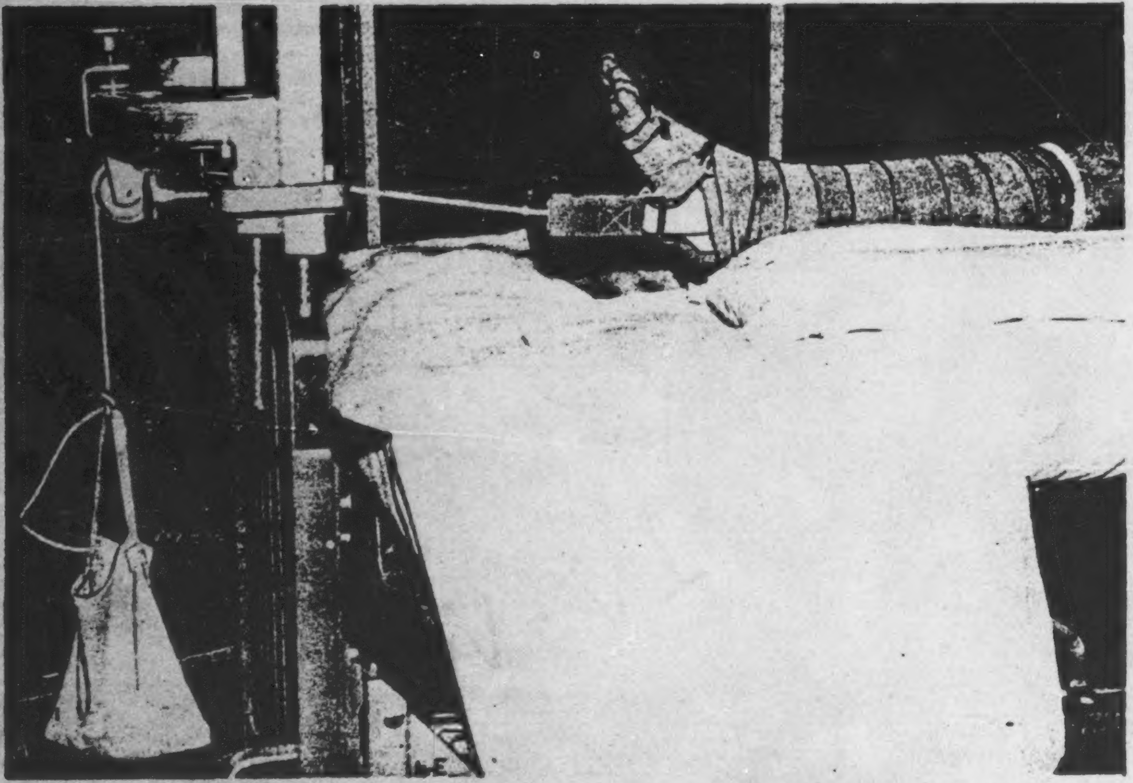

Figure 89. Buck's traction.

tached to end of straps.
(2) Two S-hooks.
(3) Eight feet of traction rope.
(4) Two pulleys.
(5) Two shot bags.
(6) Ten to twenty pounds of weight.
(7) Two large ABD pads.

b. Procedure.

(1) A corset of the correct size—large, medium, or small—is selected and placed over the hips of the patient.
(2) The end of the corset is pulled together and secured with snaps or buckles.
(3) The S-hooks are secured to the end of the rope and slipped into the rings at the end of the side straps.
(4) Ropes are run through the pulleys at the end of the bed, and the shot bags are secured to the end of the rope.
(5) An equal amount of weight (prescribed by the physician) is added to each bag, and the foot of the bed is elevated several inches.

172. Balanced Suspension With Skin Traction
(fig. 91)

Balanced suspension with skin traction may be used in temporary situations when a prolonged course of treatment is planned for a later date.

a. Equipment.

(1) One-half ring Thomas splint with strap.
(2) One canvas foot sling.
(3) Five or six canvas slings for Thomas splint.

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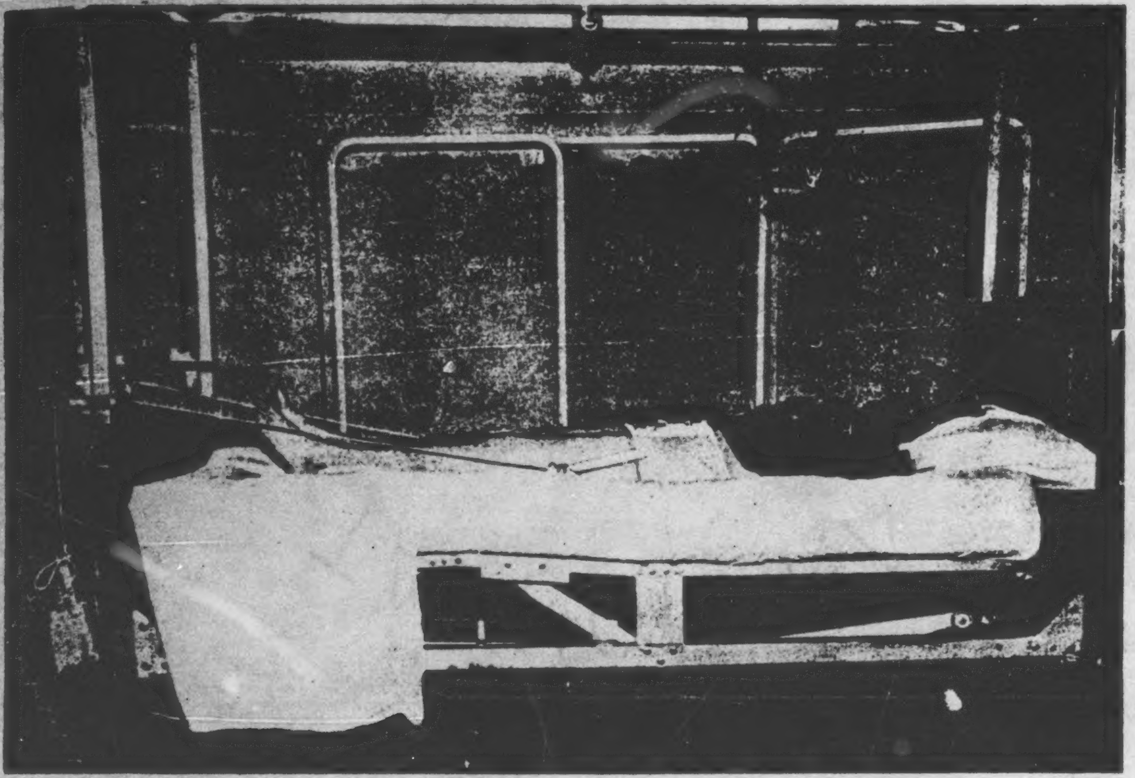

Figure 90. Pelvic traction.

(4) One hank of rope.
(5) Four canvas shot bags.
(6) Four large ABD pads.
(7) Four small ABD pads.
(8) Twenty pounds of assorted weights.
(9) Five pulleys.
(10) Same equipment needed for Buck's traction (para 170*a*).
(11) Orthopedic bed with overhead frame and foot bar.

b. Procedure. Preparation of the skin and application of traction is the same as for Buck's traction (para 170*b*). Traction should be applied before the Thomas splint is placed under the patient's limb.

(1) A splint of the correct size is selected and adjusted to the injured leg.
(2) Canvas slings are buckled to the splint, starting with the small slings at the small end of the splint and proceeding up the splint with larger slings.
(3) Two ropes about 20 inches long are secured to the inside of the splint at the half ring.
(4) Another length of rope, 18 inches long, is secured to each end of the small end of the Thomas splint.
(5) One large folded ABD pad is placed over the one-half ring, and the other ABD pad over the slings for padding.
(6) Hand traction is applied to the limb which is lifted gently while the assistant is placing the splint in place.
(7) The limb is lowered into the splint and the hand traction is released.
(8) The two ropes are tied at the upper end of the outside of the half ring.

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(9) Another rope is tied in the center of the forward rope at the half ring. The rope is passed through the pulley at the top of the frame at the head of the bed and the bag is suspended with 7 pounds of weight just below the headboard of the bed.

(10) Still another rope is tied in the middle of the second rope located at the half ring and run through the pulley on the frame above the knee. It is then run through the handle of the shot bag and through the pulley on the frame near the foot of the bed.

(11) Rope is then run through the rope tied at each side at the end of the splint and pulled until the limb is raised to the desired height.

(12) Weight (about 5 or 7 pounds) is placed in the center bag, and the rope and weight are adjusted until the limb remains suspended at the desired height. The rope is secured.

(13) Rope is run from the spreader block through the pulley at the foot of the bed. The bag is secured and prescribed weight added.

(14) A folded ABD pad is placed under the strap attached at the half ring, pulled through the buckles, and fastened (not too tight).

(15) The canvas foot sling with ABD pad folded around the bottom of the foot is placed and the foot sling (spreader

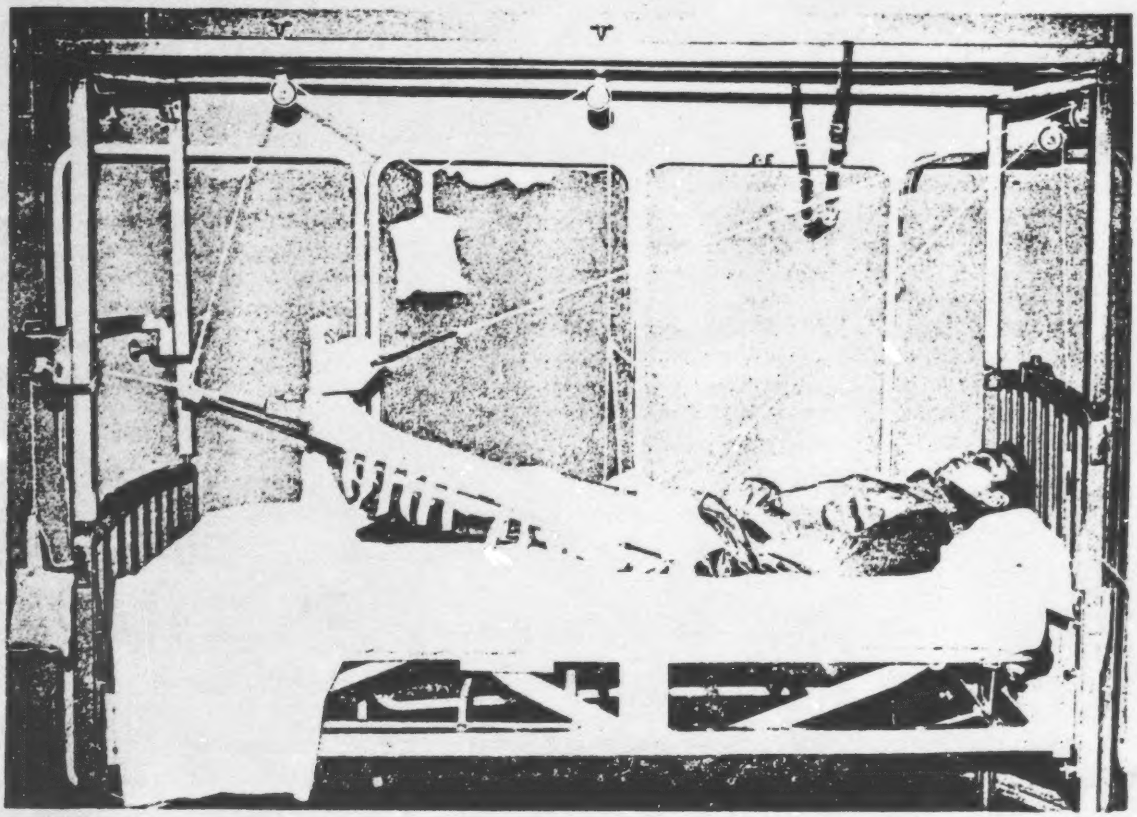

Figure 91. Balanced suspension with skin traction.

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wire) is attached to the sling. Rope is tied to the spreader, then through the pulley located near the head of the bed on the upper side of the frame. It is fastened to the shot bag, and about 2 pounds of weight are added.
(16) The patient is alined in bed, and the upper center bar is adjusted to aline with the patient.
(17) A check should be made to see that all ropes are free and shot bags are free swinging.
(18) The importance of the foot sling is explained to the patient and he is instructed how to use it.
(19) A check of the toes should be made for circulation. A final check of the traction procedure is made.

173. Russell's Traction (Skin)
(fig. 92)

Russell's traction is a basic type of traction apparatus and technique which is widely used in the reduction of fractures of the femur. It may involve either skin or skeletal traction. Russell's traction is a double-weight and a single-pulley system which transmits to the limb twice the weight used. It effects longitudinal traction on the limb by applying two separate forces—a distalward pull in the line of the femur and an upward pull, which is effected by means of a cuff placed just below the knee. The leg is supported by a pillow, or it can be supported by using a Hodgen splint. Both knee and hip are flexed. A double pulley system is necessary at the front of the bed.

a. Equipment. The equipment necessary for this type of traction consists of the following:
(1) Pan, soap, and water.
(2) Razor and blades.
(3) Two moleskin straps to extend to the knee.
(4) Two felt pads, 3 by 3 inches, ½ inch thick.
(5) One footplate with pulley in center at back of plate—1 buckle on each side of plate.
(6) Traction rope, 8 by 10 inches.
(7) Three pulleys.
(8) Ace adherent and applicator.
(9) Two pillows.
(10) Five to eight pounds of weight.
(11) One shot bag.
(12) One canvas sling with two eyes at each end.
(13) One small and one large ABD pad.
(14) One spreader with two hooks on each end.
(15) Orthopedic bed with frame and foot bar.

b. Procedure.
(1) The preparation of the skin and the application of the Ace adherent, stockinet, elastic bandage, footplate, and pads are the same as for Buck's traction (para 170).
(2) A canvas sling is placed under and just below the knee, and the spreader is hooked into the 4 eyelets at the ends of the canvas sling.
(3) The rope is threaded through the loop in the spreader, a simple knot tied in the end of the rope, and the rope is secured with a slipknot.
(4) The rope is run through the pulley at the top of the frame, just above the knee, then through the pulley at the foot of the bed on top of the bar. It is continued to the pulley at the back of the footplate, then to the pulley at the foot of the bed at the bottom of the bar. Bags of weights are secured at the end of the rope, clear of the floor.
(5) The lower leg is placed on pillows, so that there is about a 150-degree bend in the knee. The heel should be free.
(6) The foot of the bed is elevated several inches.
(7) The patient is alined with traction and made as comfortable as possible.

174. Byrant's Traction
(fig. 93)

Bryant's traction is a traction technique which is used in the treatment of fractures of the shaft of the femur in young children.

a. Equipment.
(1) Pan, soap, and water.
(2) Four small moleskin straps.

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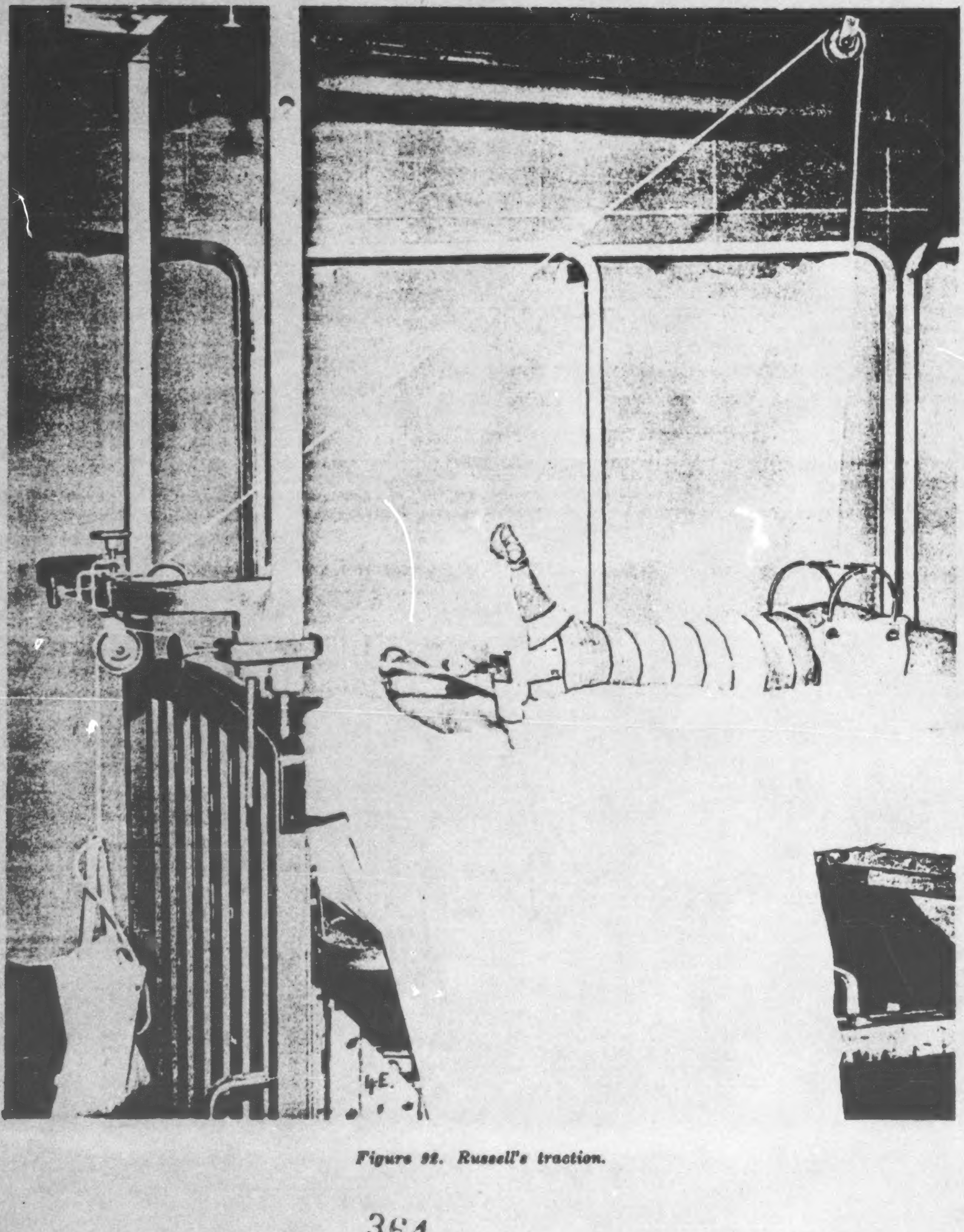

Figure 92. Russell's traction.

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(3) Two pieces of 2-inch stockinet, 10 inches long.
(4) Two felt pads, 2 by 2 inches, ½ inch thick.
(5) Two 2-inch elastic bandages.
(6) Two small spreader blocks.
(7) Traction rope, 8 feet.
(8) Four pulleys.
(9) One spreader board.
(10) Ace adherent and applicator.
(11) Two shot bags.
(12) Ten pounds of weight, depending on weight of patient.
(13) Baby bed with overhead frame.

b. Procedure.

(1) The uninjured leg is placed in traction first.
(2) Hand traction is held on the injured leg while traction is applied.
(3) Two pulleys are hung above the hip of the patient.
(4) Two more pulleys are placed near the front of the bed.
(5) Ropes are run through the spreaders and through the two pulleys located near the foot of the bed, and are then tied to the weight bags. Weight is added until the buttocks are about 2 inches off the bed.
(6) If the spreader board is used, it should be placed between the feet and the spreader block by running the straps through the holes in the spreader board.

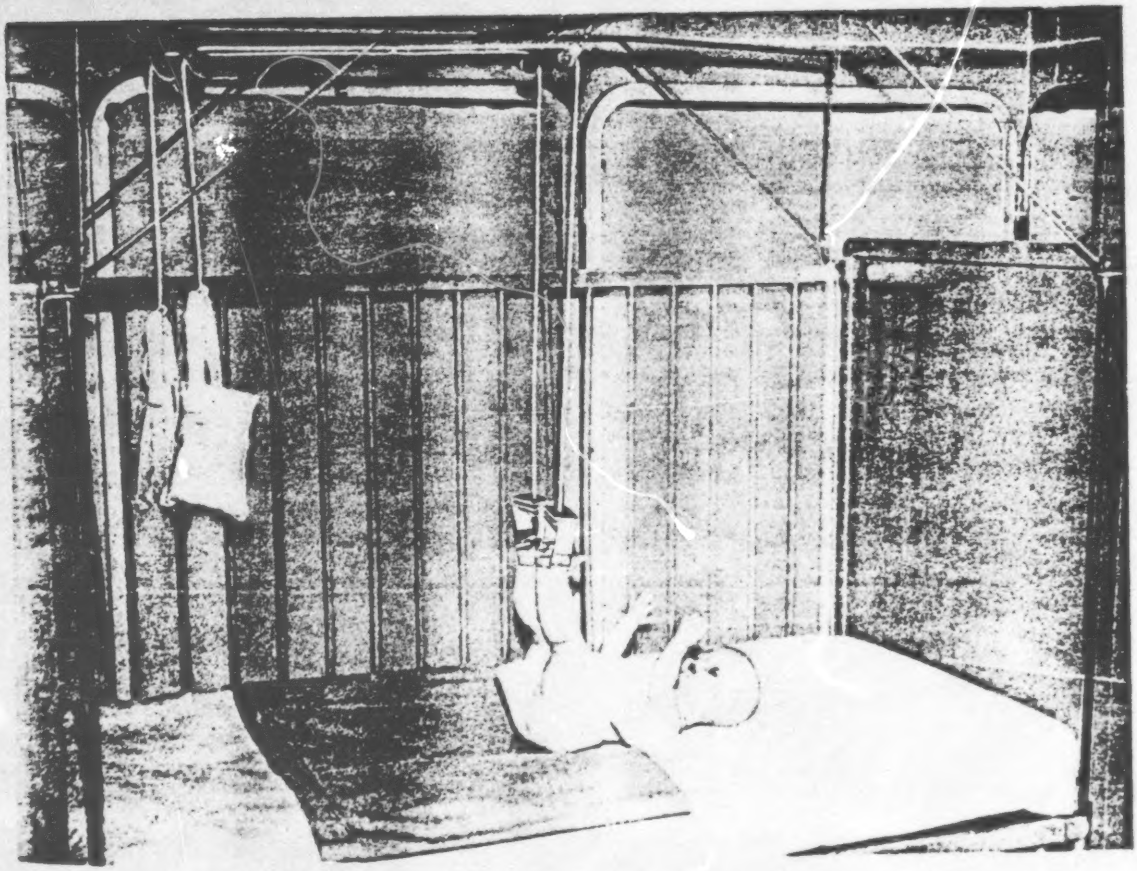

Figure 93. Bryant's traction.

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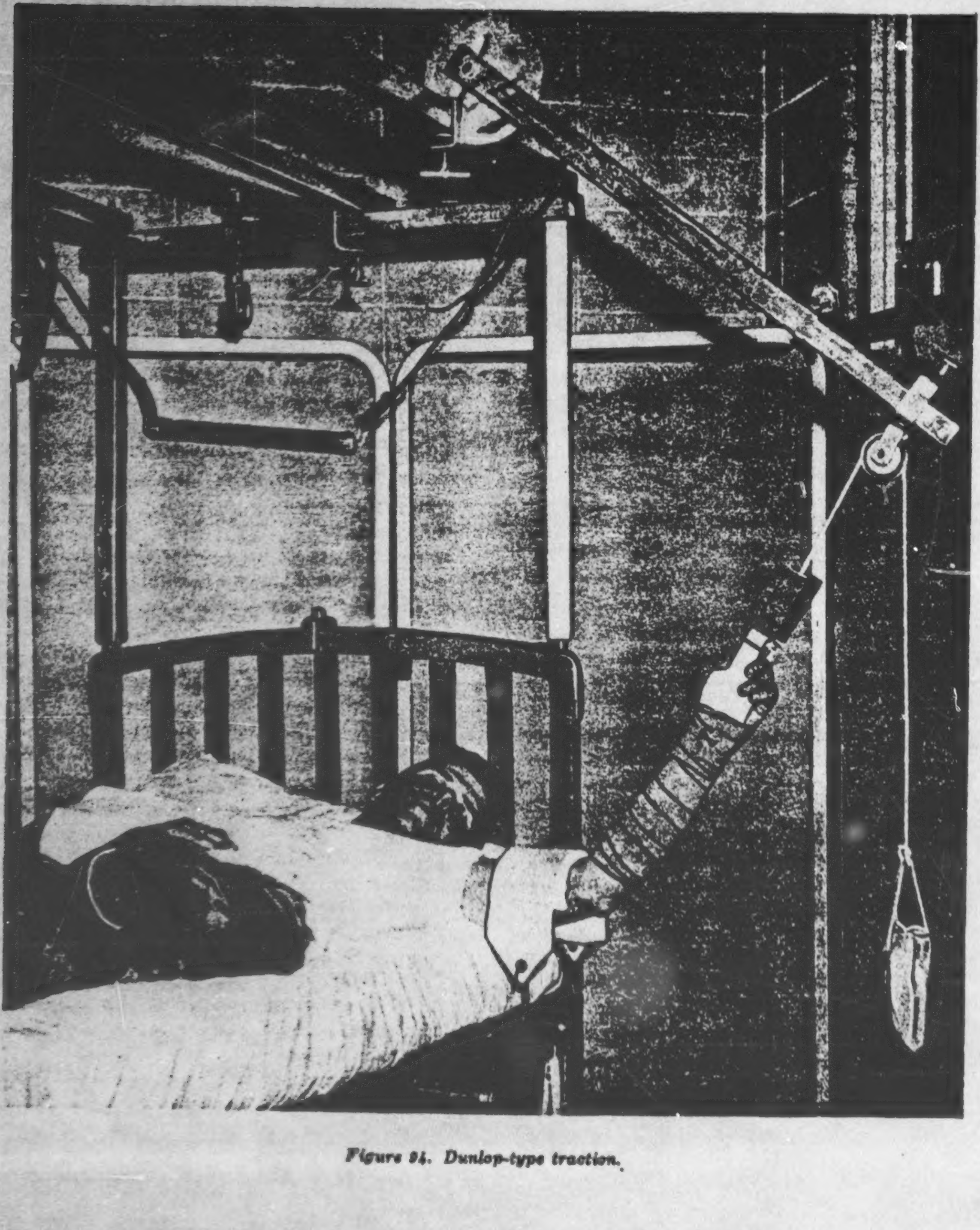

Figure 94. Dunlop-type traction.

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175. Dunlop-Type Traction
(fig. 94)

Dunlop-type traction may be used for some fractures of the elbow and for some fractures of the distal end of the humerus.

a. Equipment.

(1) Sponge bowl, soap, and water.
(2) Sponges, 4 by 4 inches.
(3) Ace adherent and applicator.
(4) Two moleskin straps, 8 inches long.
(5) One piece of stockinet, 12 inches long.
(6) One elastic bandage, 3 inches.
(7) One spreader block.
(8) Two pulleys.
(9) Traction rope, 4 feet.
(10) Two felt pads, 3 by 3 inches, ½ inch thick.
(11) One canvas sling, or 4-inch stockinet, 14 inches long.
(12) One small ABD pad.
(13) Two 6-inch shock blocks.
(14) Orthopedic bed with overhead frame and extension bar.

b. Procedure.

(1) The standard procedure is checked and the extremity is prepared (washed and prepared when necessary).
(2) Ace adherent, moleskin, stockinet, and spreader are applied. The spreader should extend beyond the tips of the fingers.
(3) Rope is run through the pulley at the end of the extension bar which is attached to the overhead frame. The rope is tied to the bag.
(4) The prescribed weight is added and the pulley adjusted so the elbow will form an angle of about 45 degrees.
(5) The patient is alined in bed.
(6) A 6-inch shock block is placed under the head and foot of the bed on the side of the fracture.

176. Thomas Splint and Pearson Attachment (Skeletal Traction)
(fig. 95).

The Thomas, or Army half-ring, splint, recumbency type, is widely used for traction suspension treatment of fractures of the femoral shaft. The Pearson legpiece may be attached to this splint by means of special clasps which are attached to the piece.

a. Equipment

(1) Sterile preparation setup.
(2) Sterile pin tray setup.
(3) Mayo stand.
(4) Two pairs of gloves, sterile.
(5) Bottle of anesthetic (the type prescribed).
(6) Thomas splint half-ring.
(7) Pearson attachment.
(8) Five canvas slings.
(9) Four large ABD pads.
(10) Four small ABD pads.
(11) One hank of rope.
(12) Four canvas shot bags.
(13) About 25 or 30 lbs of weight.
(14) Two 6-inch shock blocks.
(15) Six pulleys.

b. Procedure.

(1) The procedure for preparation is as described in paragraph 164.
(2) The Thomas splint and Pearson attachment are used.
(3) Application of the Thomas splint is the same as for the Thomas splint in skin traction (para 172*b*).
  (*a*) The Pearson attachment is attached to the Thomas splint at the knee.
  (*b*) A rope is tied to the end of the Pearson attachment and secured to the end of the splint at the desired leg height.
  (*c*) The rope is secured to the S-hook.
  (*d*) The S-hook is attached to the traction bow.
  (*e*) The rope is run through the pulley at the end of the bed, and the end of the rope is secured to the weights.
  (*f*) The patient is alined in bed with traction.
  (*g*) A final check is made.

177. Suspension, Upper Limb
(fig. 96)

Suspension, upper limb, may be used after

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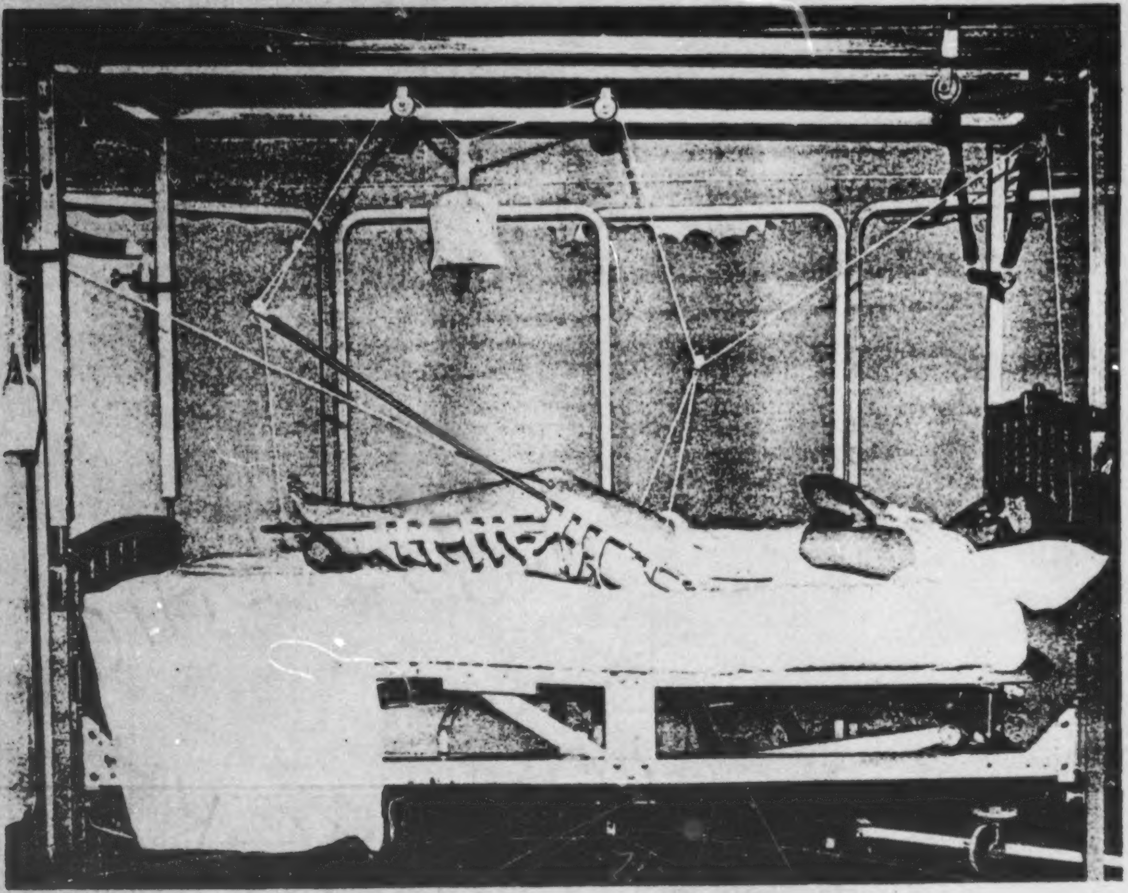

Figure 85. Thomas splint and Pearson attachment (skeletal traction).

surgery of the forearm and hand, for infection of the forearm and hand, and after injury of the forearm.

a. Equipment.

(1) Stockinet, 6 inches wide, 40 inches long.

(2) Twelve or 15 large safety pins.

(3) Roller gauze, 3 inches wide.

b. Procedure.

(1) A 6-inch stockinet is folded end to end, and the sides pinned every 4 inches.

(2) Safety pins are omitted at the end of the fold on one side, and the arm is slipped through the sling on this side.

(3) The arm is secured in the sling at the elbow with pins.

(4) A hole is cut in the upper end of each side of the stockinet, and a 3-inch gauze strip is run through the hole and tied to the I.V. standard.

(5) The upper arm should rest on the bed.

(6) The elbow should form a 90-degree angle.

(7) Ice bags can be placed inside the stockinet sleeve next to the area where desired if ordered by the physician.

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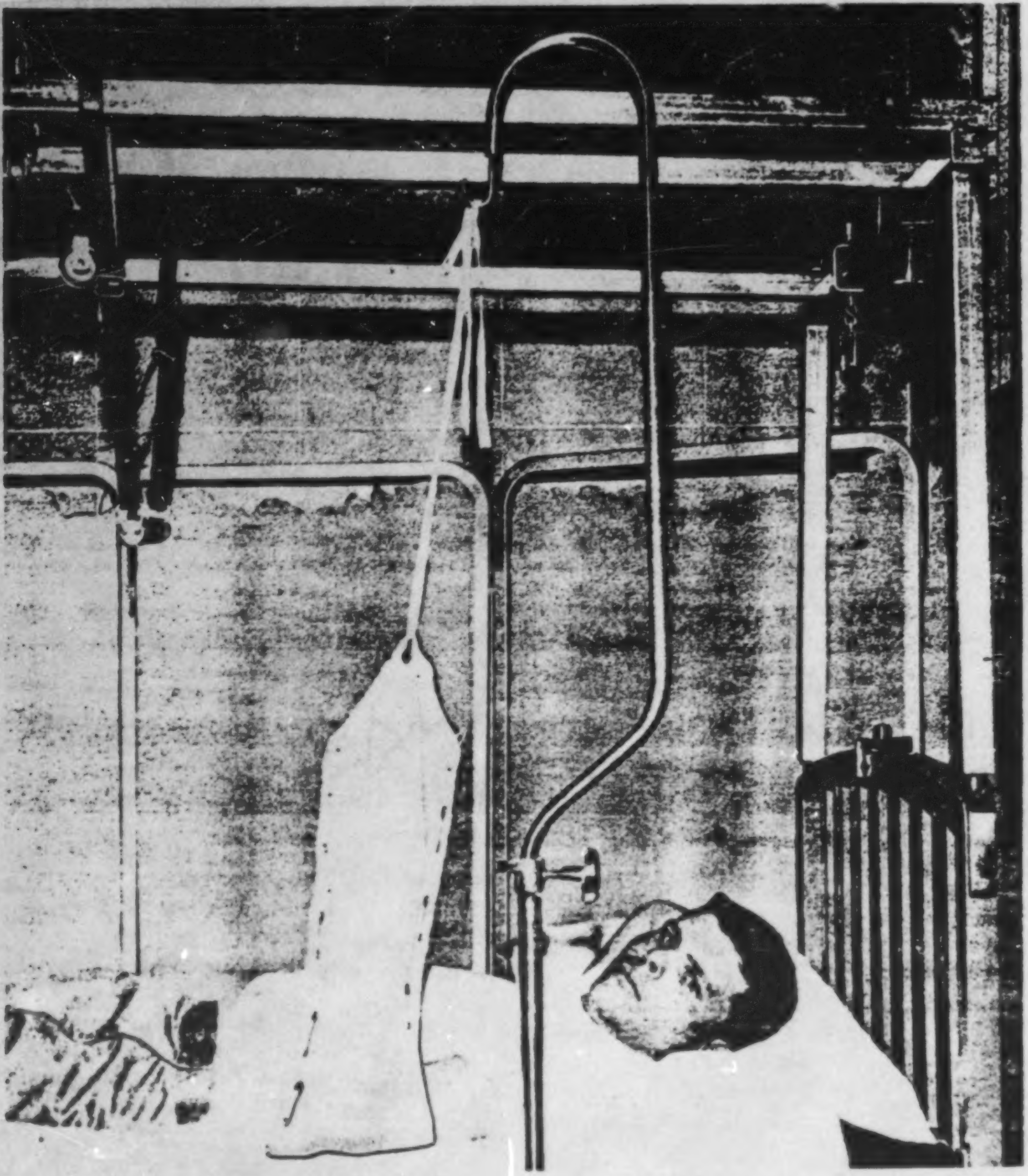

Figure 98. Suspension, upper limb.

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178. Suspension, Lower Limb in Plaster (fig. 97)

Suspension, lower limb, may be used after surgery, after injury, and for infection of the lower limb.

a. Equipment.

(1) Two canvas slings.
(2) Two canvas sling yokes.
(3) Two pulleys.
(4) Rope, 4 feet.

b. Procedure. This procedure is used when the patient is in a cast or posterior splint. (If leg is not in a cast or splint, it can be placed on a pillow to desired height.)

(1) One canvas sling is placed under the leg near the ankle and the other near the knee.
(2) The pulleys are placed on the overhead frame over the sling.
(3) The rope is tied to the yoke and the yoke placed in the holes in the canvas sling near the ankle.
(4) The rope is threaded through the pulley on the frame over the sling, and then run through the other pulley on the frame over the knee.
(5) The yoke is attached to the canvas sling at the knee.
(6) The rope is fed through the eye in the yoke and pulled until the foot is at the desired level or height.
(7) The rope is secured at the yoke so the leg will remain suspended.
(8) The setup is checked.

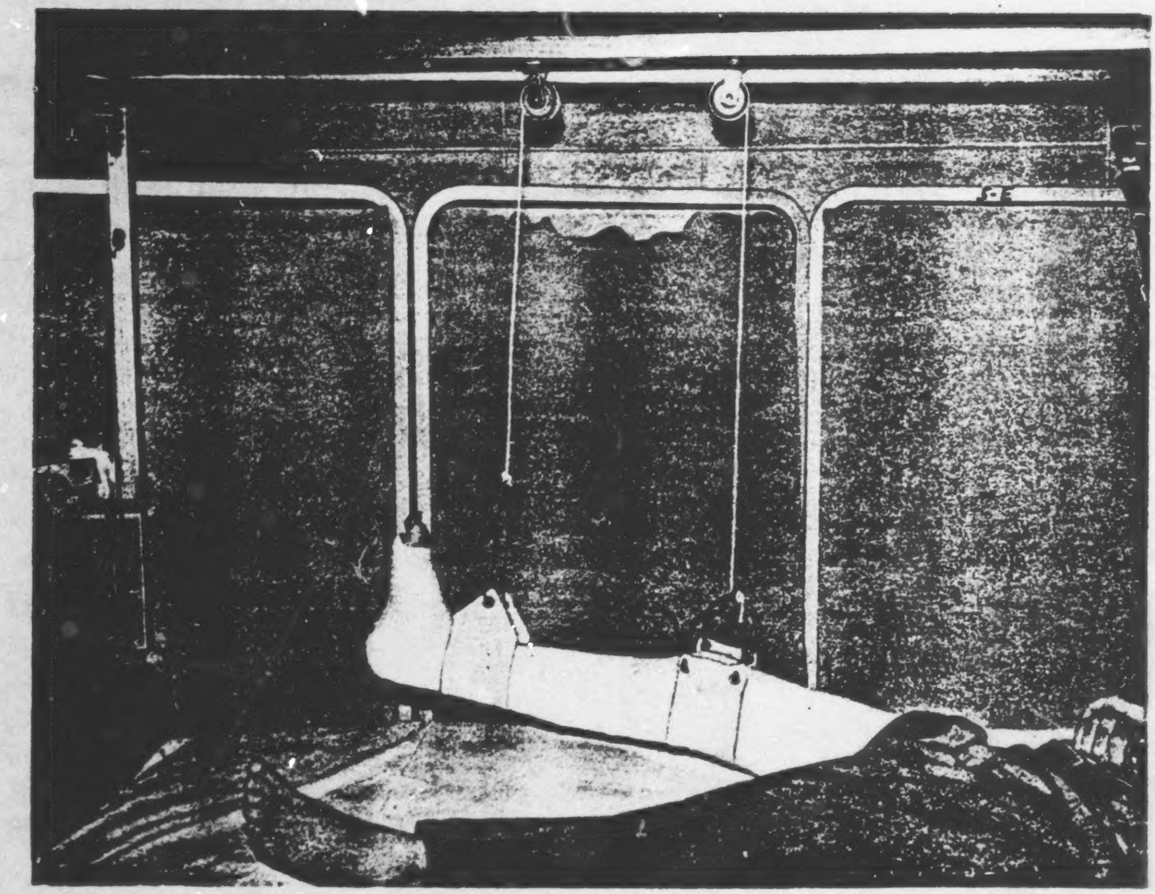

Figure 97. Suspension, lower limb.

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179. Pearson Attachment Hooked Up for Knee Motion
(fig. 98)

a. Equipment. Equipment for this type of traction is the same as for the Thomas splint and Pearson attachment (skeletal traction) (para 176*a*), in addition to the following:

(1) Traction rope, 7 feet.
(2) One shot bag.
(3) Weight, 5 to 8 pounds.
(4) Two pulleys.

b. Procedure. This procedure is basically the same as for the Thomas splint and Pearson attachment in skeletal traction.

(1) The distal end of the Pearson attachment should not be attached to the Thomas splint with rope.

(2) Instead, rope is tied to the distal end of the Pearson attachment. The rope is run through the pulley on the overhead frame at the end of the bed above the splint, and through the pulley near the head of the bed to one side.

(3) The patient's limb must be in alinement with the overhead frame or the bar holding the pulleys and there must be enough weight to balance the limb when placed in the splint.

(4) The patient is instructed to push up and down on the bag of weight suspending the Pearson attachment. By doing this, the knee will flex and straighten out, thus exercising the knee. He is instructed to try it out several times.

(5) The setup is checked.

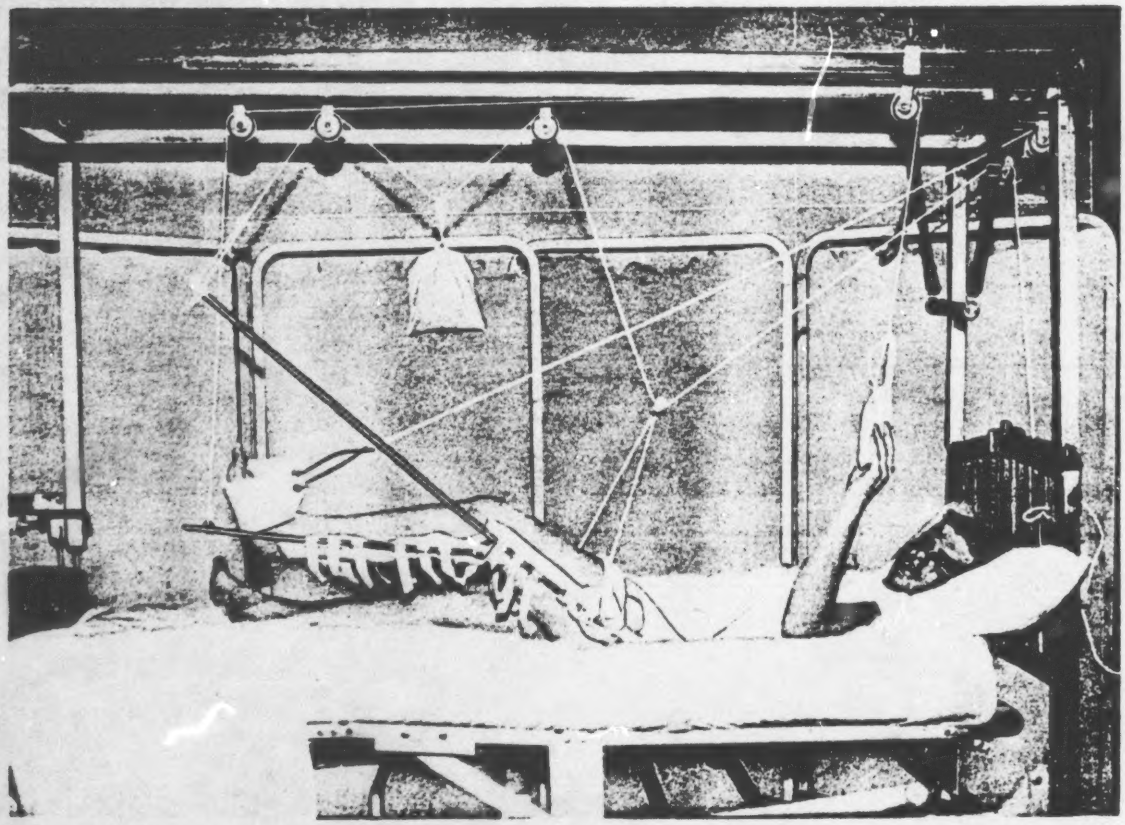

Figure 98. Pearson attachment hooked up for knee motion.

180. Traction Cart
(fig. 99)

The equipment on the traction cart includes the following:

a. Ten pulleys.

b. Ten shot bags.

c. Weight, 50 pounds.

d. One hank of rope (traction).

e. Ten spreader blocks (6 adult, 4 children).

f. Russell's traction foot plates.

g. Canvas foot slings.

h. Eight leg slings—2 eyes on each end.

i. Six spreaders for foot slings.

j. Four spreaders for leg slings.

k. Bottle of Ace adherent.

l. Three head halters—large, medium, small.

m. One package of large ABD pads.

n. One package of small ABD pads.

o. Two Thomas splints and Pearson attachment made up.

p. Three pelvic corsets—large, medium, small.

q. One spool of tape.

r. One pair of bandage scissors.

s. One pair of pliers.

t. Elastic bandage, 2 inch, 3 inch, 4 inch and 6 inch (four each).

u. Twelve S-hooks.

v. Stockinet, 2 inch and 3 inch, (one roll each).

w. Six moleskin straps (adult size).

x. Six moleskin straps (child size).

y. Muslin, one roll.

z. Sheet wadding, two rolls.

aa. Pack of sterile, 4 by 4 inches.

ab. One set of shock blocks, 6 inches.

ac. One 6-inch Kelly, straight.

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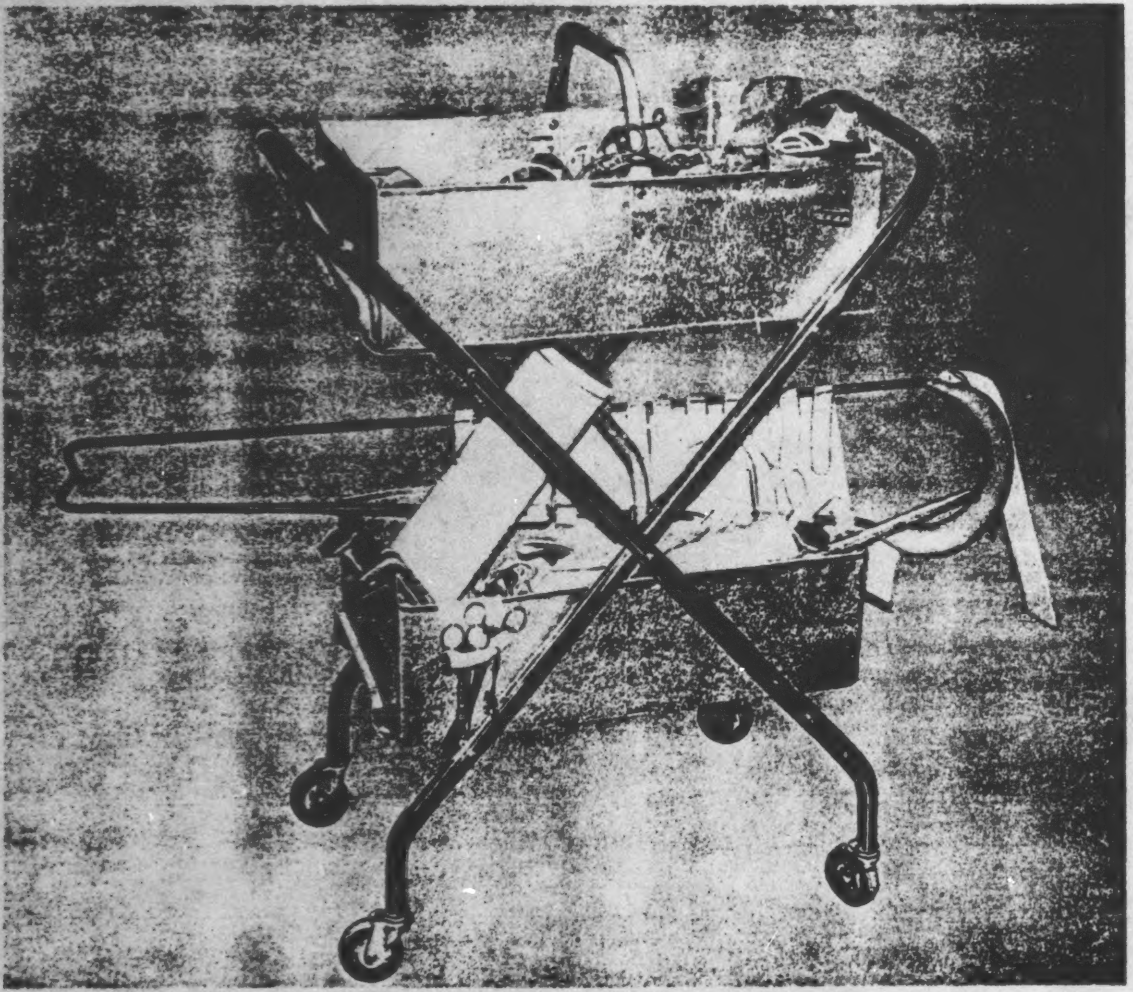

Figure 99. Traction cart.

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CHAPTER 14

GENERAL PATIENT CARE OF SPECIFIC ORTHOPEDIC PATIENTS

181. Care of the Patient in a Cast

Care of the patient in a cast involves the following precautions and observations:

a. If the cast is wet when the patient is moved from the cast room, *it should be handled carefully while it is drying* so as to maintain the affected part of the body in the proper alinement. A fracture bed with a firm mattress resting on boards, or a commercial fracture bed, should be prepared. The cast should be moved by supporting it on rubber-covered pillows or on the palms of the hands. *The fingers should not be used,* since they will leave indentations, which may cause pressure sores when the cast hardens. While the cast is still wet, the limbs should be carefully checked for signs of tightness of the cast. The cast usually requires about 48 hours for drying. It should be dried by exposing it to the air or the sunlight.

b. When the cast is dry, the rough edges should be covered with plaster splint to prevent crumbling of the plaster. Water-proof material should be tucked under the edges of the cast and taped into place.

c. The exposed limb should be checked for impairment of circulation. Any signs of swelling, cyanosis, numbness, coldness, pallor, or blanching should be reported immediately. The patient should also be checked for signs of infection or complication (musty odor, pain, burning sensation, or elevated temperature) and for pressure areas. If the patient complains that the cast hurts him, it should be reported at once.

d. If possible the patient's position should be changed frequently, making certain that good body alinement is maintained. The patient should be encouraged to exercise to the greatest extent possible, since exercise will maintain muscle function.

182. Care of Patient in Traction

In attending the patient in traction, the traction apparatus should be checked continually and any defect should be reported immediately. The following questions concern points which should be observed:

a. Is the rope dragging on the bed or covers?

b. Is the bag of weights resting on the floor or against the bed?

c. Is a rope off its pulley?

d. Has the patient slid down in his bed?

e. Is the splint crooked?

f. Has the splint slipped off the ischium of a patient in a Thomas leg splint?

g. If there is a cast, is it causing pain?

h. Is the cast broken?

i. Are there plaster particles on the skin under the cast?

183. Care of the Patient in a Turning Frame

a. Patients who have had an injury to the spine or spinal cord or surgery in this area, patients who have had extensive burns, and post-polio patients who are paralyzed are frequently placed in turning frames. In this device, turning may be accomplished without disturbing an immobilized trunk or spine and nursing care is more easily given. Two turning frames in wide use today are the *Stryker turning frame* (fig. 100) and the *Foster reversible orthopedic bed* (fig. 101).

b. Both are double frames which can be rotated on the longitudinal axis. Their operation is similar in principle. The chief difference is that the Foster bed can be adjusted for hyperextension and the Stryker frame requires separate hyperextension frames. The

Foster bed is much heavier than is the Stryker and it takes care of larger patients. Both beds can be elevated at either the foot or the head to provide traction, and each has a rotary-bearing pulley traction apparatus at both ends to maintain traction during the turning process.

c. The patient is sandwiched in between two frames when he is turned. The frame on which he lies prone is called the *anterior* frame. The frame on which he lies supine is called the *posterior* frame. Both frames are fitted with canvas which is laced on tightly to the metal framework. They have middle sections which can be removed when the bedpan is used. The anterior frame cover extends from just below the shoulder girdle to the ankles and is divided into two sections. The forehead is supported by a padded canvas strip or a folded towel. The lower section of the canvas extends from 4 inches below the symphysis pubis to the internal malleolus, leaving the feet free. The posterior frame covers are also divided and leave a 4- to 6-inch perineal opening, which corresponds to the opening left in the anterior cover. A removable buckle strap which supports the open space should be kept in place at all times, except when the bedpan is being used. A footboard, used to support the feet when the patient is in the supine position, prevents drop foot and maintains good foot alinement. When the patient is in the prone position, his feet should hang free and be perpendicular to the floor.

184. Turning the Patient in a Stryker Frame

The patient should be told when and in which direction he is going to be turned. Turning the patient involves the following steps:

a. From Prone to Supine.

(1) First, the bed clothing, foot supports, and arm rests are removed, drainage tubes are clamped and detached, and pillows are placed over the lower limbs to prevent them from slipping during the turning process.

(2) The round nuts are removed and the second frame is lowered, fitting the patient snugly between the two frames.

(3) Turning straps are placed around the frames at the level of the elbows, hips, and knees.

(4) The patient is instructed to grasp the rod beneath the frame.

(5) The locking springs are pulled out, the patient is warned, and then the frame is quickly and smoothly rotated toward the person who is carrying out the procedure. Care is taken to make sure that the spring locks catch and are securely locked.

(6) The top frame is removed and the round nuts are replaced on the pivots. Added supports and drainage tubes are attached.

(7) A small pillow is placed under the patient's head, if allowed, and the arm boards and the footboard are replaced.

(8) Last, the general body alinement is checked and the bedding is replaced.

b. From Supine to Prone.

(1) The bed clothing and the small pillow under the head are removed. The arm boards are removed and the patient's arms are placed at his side; if he is paralyzed, his arms are placed slightly under his body.

(2) Pillows are placed across the patient from his ankles to his chin, or the special mattress and sheet are secured to the anterior frame.

(3) The frame is fit down snugly over the patient and locked in place (foot end first).

(4) The turning straps are placed around the frames at the level of the elbows, hips, and knees, and the patient is instructed to grasp the rod beneath the frame.

(5) The round locking pin is pulled out at the center of each end.

(6) The patient is turned slightly and warned that he is about to be turned over.

(7) The lock is released and the patient

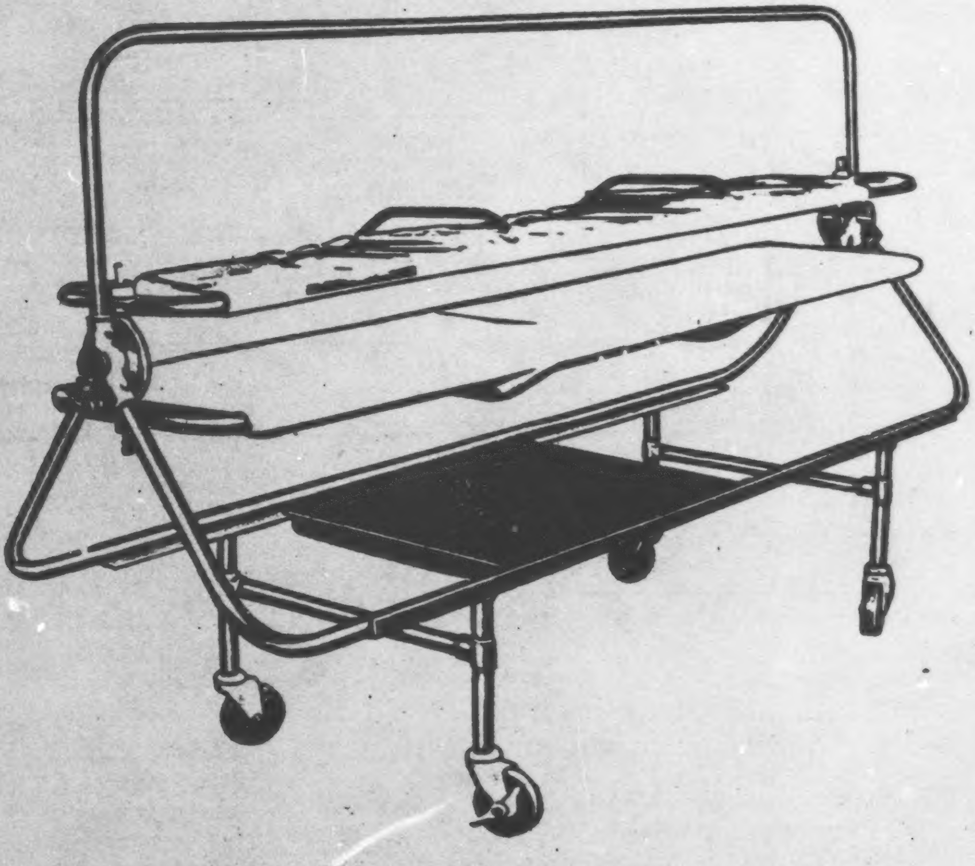

Figure 100. Stryker turning frame.

is turned quickly. Although the frame will automatically lock itself, both ends must be checked to make sure that they are locked.

(8) The posterior frame is now released and removed.

(9) The arm boards are replaced with pillows, if they are needed, and the bed covers are replaced.

185. Care of the Amputation Stump

a. One of the most important steps in the postoperative care of the stump in preparation for the fitting of the prosthesis is bandaging. Bandaging decreases postoperative edema and helps to shrink the stump.

(1) A fairly tight elastic bandage should be kept wrapped around the stump at all times, except when it must be removed for other forms of treatment. The widest possible bandage consistent with smooth wrapping should be used. Narrow bandages constrict rather than compress.

(2) It is important to remember that the pressure of the bandage must be from

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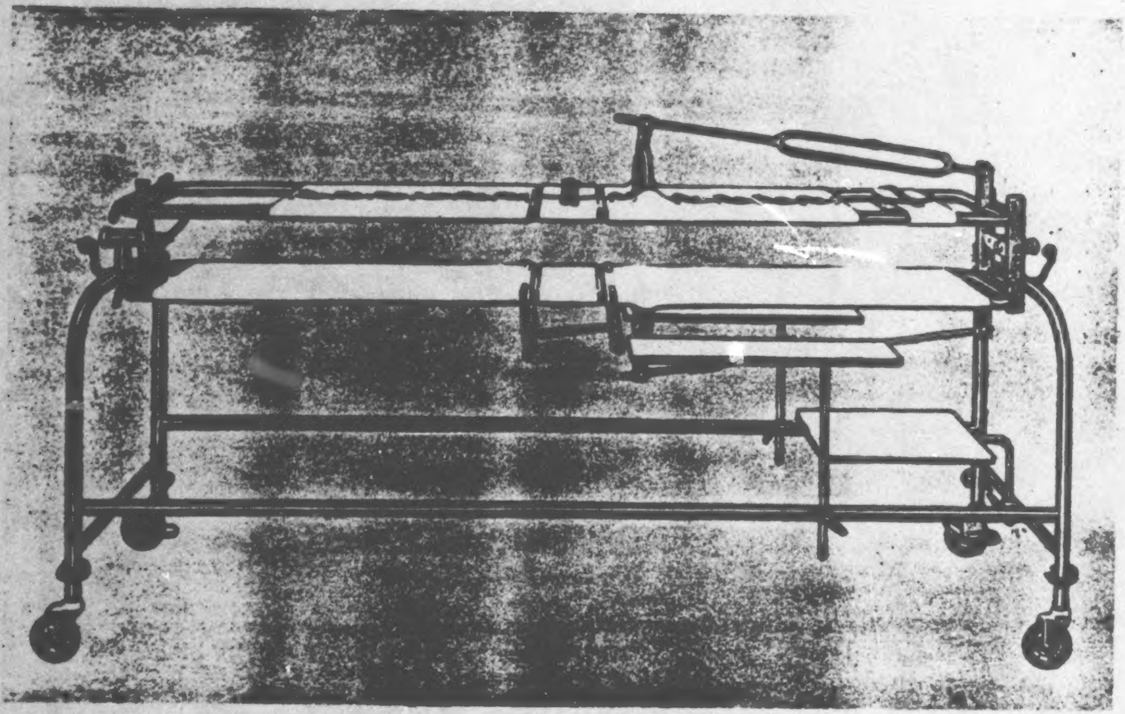

Figure 101. Foster reversible orthopedic bed.

the distal end upward, gradually relaxing in pressure as it goes upward and making sure that the end of the stump is covered. If the pressure of the bandage is from above downward, it has a tendency to increase the edema in the stump.

(3) To bandage a below-knee amputation, for example, the bandaging should be started on the anterior surface of the stump directly under the patella, run longitudinally around the distal end of the stump, and extended upward on the posterior side of the stump to a point even with the anterior part of the bandage. Then it should be wrapped around the circumference of the stump loosely until the end of the stump is reached, at which point the bandage is tightened and wrapped tightly from this point upward. The bandage must be wrapped up to the proximal joint in order to provide a smoothly conical stump. In high thigh amputations, the bandage must include the pelvis in a spica fashion to prevent the bandage from slipping off the stump.

b. Massaging the stump for 10 to 20 minutes daily is another therapeutic aid in reducing stump edema and in helping to shrink the stump.

c. All stumps of the lower limbs tend to develop a flexion contracture at the hip. This is particularly true of above-knee stumps. In order to avoid this, *it is absolutely necessary that the stump not be supported by a pillow following the amputation*, but be placed in the proper position in full extension on a hard bed. An earlier means of preventing this flexion deformity following operation is the continued use of skin traction.

d. Exercising the stump is another important phase in the postoperative care. Correct exercising will prevent a flexion deformity and will also build up muscle power. It is well to develop this muscle power by exercise before the stump is fitted. In above-knee amputee patients, resistive extension and adduction exercises of the stump are of great value in preventing flexion and adduction contractions. Active, passive, and resistive exercises in all types of amputations, both lower and upper limbs, are a great value in preventing any flexion deformity of the stump and in aiding and building up any muscular weakness.

e. It is equally important to see that the amputee patient exercises good stump hygiene following the fitting of his prosthesis.

(1) He should always wash his stump in warm water and non-irritating soap thoroughly each night before he retires.

(2) Following this, a brisk massage with rubbing alcohol will be effective in keeping the skin toughened.

(3) Talcum powder may be used to prevent irritation of the skin.

f. It is necessary that the amputee patient be instructed in the proper care of the stump socks. To avoid skin irritations, stump socks should be changed daily and kept exceptionally clean. They should be washed in warm water with a good grade of pure white soap, rinsed thoroughly in water, and hung open end down in the shade, so that they will not be exposed to sun or heat. Stump socks are generally made of pure virgin wool. Since some patients are allergic to wool, it is recommended that special silk or cotton stump socks be ordered for their use. Correct fitting of the prosthesis should require the patient to wear only one stump sock at a time. Stump shrinkage, however, may make it necessary for the patient to wear from two to three stump socks until he can have his prosthesis relined and refitted so that only one stump sock will be required.

APPENDIX I

REFERENCES

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AR 40-3	Medical, Dental, and Veterinary Care
AR 320-5	Dictionary of United States Army Terms
AR 320-50	Authorized Abbreviations and Brevity Codes
SR 32-160-40	Orthopedic Adjustments to Shoes
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TM 8-295	Physical Therapy Specialists
TM 8-640	Joint Motion Measurement

2. Other References

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APPENDIX II

PREOPERATIVE ORTHOPEDIC PROCEDURE

1. Skin preparation will be done the day before the scheduled date of operation.
2. Areas to be prepared are as follows:
   - *a. Hand Preparation.*
     - (1) Tip of fingers to elbow.
     - (2) Manicure.
   - *b. Arm Preparation.*
     - (1) Tip of fingers to axilla.
     - (2) Axillary preparation.
     - (3) Manicure.
   - *c. Shoulder Preparation.*
     - (1) Manicure. From finger tips and including entire upper extremity and axilla.
     - (2) Front and back of shoulder to hairline behind and to jaw in front.
     - (3) Medially to midline of chest and down as far as nipples.
   - *d. Back Preparation.* Entire back from above shoulders to below buttocks.
   - *e. Neck Preparation.*
     - (1) Upper back above waist.
     - (2) Back of neck and scalp to upper level of ears.
   - *f. Foot Preparation.*
     - (1) Tip of toes to knee.
     - (2) Pedicure.
   - *g. Leg Preparation.*
     - (1) Tips of toes to perineum.
     - (2) Pedicure.
     - (3) *No* perineal preparation.
   - *h. Hip Preparation.*
     - (1) From tips of toes and including entire lower extremity.
     - (2) Pedicure.
     - (3) Perineal preparation.
     - (4) Buttocks and abdomen on both sides to level of sternum.
   - *i. Iliac Preparation.* Same as hip preparation, except only down to knee.
3. Preparation in area specified is to be as follows:
   - *a.* Shave *entire area* carefully, *avoiding breaking of skin.*
   - *b. Thorough* cleansing of entire area with surgical soap and water. Five-minute scrub.
   - *c.* On "shave only" cases: Shave, use surgical soap but do not drape.
4. *a.* Patients with lower extremity, back, and neck preparations are to remain *IN BED* until time of operation.
   - *b.* Patients with shoulder, arm, and hand preparation must remain on the ward but may be up and about.
5. If any skin defect is noted in the preparation of clean operative cases, the Ward Officer will be immediately notified.

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APPENDIX III

SAMPLE STANDING OPERATING PROCEDURE FOR CAST ROOM

1. There will be an NCO in charge of the cast room. He is responsible to the Chief, Orthopedic Service, or his authorized representative.

2. Duty hours will be from 0745–1630 hours, Monday through Friday and 0745–1200 on Saturday.

3. Cast room personnel will remain on duty in adequate numbers until the work of the day has been completed.

4. An emergency on-call roster will be maintained, so that an orthopedic specialist is always available on off-duty hours.

5. All clinic and shop areas will be in order before personnel leave their duty stations. The cast room will be cleaned and supplied by the man on call, if this has not been accomplished during duty hours.

6. Hours off and all leaves and passes will be arranged by the NCO in charge. All leaves and passes must be approved by the Office of the Chief, Orthopedic Service.

7. The NCOIC of the cast room will be responsible for maintaining the approved list of orthopedic equipment at all times.

8. Smoking is not permitted in any part of the cast room area.

9. On surgery days at least one cast room specialist will be present in the operating room between 0800 and the time the scheduled operations have been completed. Whenever the fracture table is employed in surgery, the specialist will report to the operating room at least 30 minutes before the scheduled time of operation.

10. Orthopedic specialists will report their destination to the NCOIC if they leave their duty stations during duty hours.

11. Cast room work and traction procedures will be accomplished ordinarily by direct order of a physician to the Orthopedic Service, or by a written request signed by him. Requests for such procedures from physicians assigned to other hospital services should be cleared through the Chief of the Orthopedic Service unless they are urgently required, in which case they will be promptly carried out.

12. Complete and accurate records of the number of cast room procedures performed will be maintained and submitted as a monthly report to the Chief, Orthopedic Service.

13. There will be one representative of the cast room present at the time of grand ward rounds.

SUBJECT: Shortleg Cast W/Walker
INSTRUCTOR:
DIVISION: Orthopedic Service

I. INTRODUCTION: (1 MIN)

A. Opening Statement. As Orthopedic Specialist you will be required to apply cast on patients. You will not be able to perform this task adequately if you do not know anything about the job you are to perform. This demonstration is to prepare you to execute this task with confidence and with an abundance of efficiency.

B. Objectives.

1. State the definition of a cast.
2. State the purpose of a cast.
3. List the materials needed to apply a short leg cast w/walker.
* 4. After practice, perform the proper procedures in applying a short leg cast with walker.

C. Class procedure and lesson tie-in.

1. Your previous class you were taught the uses of a cast.
2. This demonstration relates to practical exercises and later clinical performance.

II. EXPLANATION/DEMONSTRATION: (43 MIN)

A. Definition.

QUESTION: What is a cast?

ANSWER: A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing the plaster to harden.

B. PURPOSE.

QUESTION: Why do we use cast?

ANSWER: Cast are used to immobilize and hold fractures in place, to maintain alignment, and to prevent movement of soft tissue injuries.

C. MATERIALS

1. Water 70-80 degrees.
2. Stockinet
3. Webril
4. Six inch plaster
5. Four inch plaster
6. Large splints
7. Small Splints
8. One cast knife
9. One pair of scissors

*TERMINAL OBJECTIVE

10. One walking heel
11. One pillow with plastic cover.

D. PROCEDURES

1. Apply stockinet from toe to 3 inches below knee.
2. Apply webril from toe to 3 inches below knee.
3. Apply plaster from toe to 3 inches below knee.
4. Apply large splints from bottom of toes posteriorly up the limb 3 inches below knee.
5. Apply another roll of plaster to tie-in splint.
6. Mold cast before it dries.
7. Have patient to place cast on plastic covered pillow.
8. Trim cast with cast knife.
9. Use scissors to cut stockinet
10. Wet stockinet and tie-in with small splint
11. Use small splints and make foundation for walking heel.
12. Apply walking heel and tie-in with plaster of paris.

E. SUMMARY FROM STUDENTS.

III. SUMMARY: (1 MIN)

A. Review of main points.

1. Definition of a cast
2. State the purposes of a cast
3. List materials needed to apply a short leg cast with walker.
4. After practice, perform the proper procedures in applying a short short leg cast w/walker.

B. Closing statement. During this period we demonstrated the proper procedures in applying a short leg cast with walker. If you put this to good use your task will be much easier, and you will perform your job with a higher degree of efficiency.

BROOKE ARMY MEDICAL CENTER
DEPARTMENT OF SURGERY
ORTHOPEDIC SPECIALIST COURSE

Demonstration Guidelines

OBJECTIVES.

1. State the definition of a cast.
2. State the purposes of a cast.
3. List the materials needed to apply a short leg cast with walker.
4. After practice, perform the proper procedures in applying a short leg cast w/walker.

A. Definition = A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing the plaster to dry.

B. Purpose = Casts are used to immobilize and hold fractures in place, to maintain alignment, and to prevent movement of soft tissue injuries.

C. Materials

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10.
11.

D. Procedures

1. Apply stockinet from toe to 3 inches below knee.
2. Apply Webril from toe to 3 inches below knee.
3. Apply plaster roll from toe to 3 inches below knee.
4. Apply large splints from bottom of toes posteriorly up the limb.
5. Apply another roll of plaster to tie-in splints.
6. Mold cast before it dries.
7. Have patient to place cast on plastic covered pillow.
8. Trim cast with cast knife.
9. Use scissors to cut stockinet.
10. Wet stockinet and tie-in with small splints.
11. Use small splints and make foundation for walking heel.
12. Apply walking heel and tie-in with plaster of paris.

SUBJECT: Short Arm Cast
INSTRUCTOR:
DIVISION: Orthopaedic Service

I. INTRODUCTION: (1 MIN)

A. Opening Statement - Why do patients fear having cast put on them? Could it be from listening to other patients? This demonstration is to better acquaint you with the proper techniques in applying the short arm cast. By applying these techniques properly the patients will have more confidence and lose this fear.

B. OBJECTIVES

1. State the definition of a cast.
2. State the purpose of a short arm cast.
3. List the materials needed in applying a short arm cast.
4. * After practice, perform the proper techniques in applying a short arm cast.

C. Class procedures and lesson tie-in.

1. Your previous class you were taught the uses of short arm cast.
2. This demonstration relates to practical exercises and later clinical performances.

* TERMINAL OBJECTIVE

II. EXPLANATION/DEMONSTRATION: (28 MIN)

A. Definition

QUESTION: What is a cast?

ANSWER: A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing the plaster to harden.

B. Purpose

QUESTION: Why do we use the short arm cast?

ANSWER: Short arm casts are used for sprains, dislocations, and fractures below the elbow, and also post-op patients.

C. Materials

1. Stockinet, 3 by 18 inches.
2. Cotton wadding, 4 inches, or webril 3 inches.
3. Padding.
4. Three 3 inch rolls of plaster of paris.
5. Water 70-80 degrees.
6. Splint, optional
7. Scissors.
8. Cast knife.

D. Procedures

1. Stockinet, 3 by 18 inches is applied with a hold cut for the thumb from the distal end of the knuckles and the distal palmar crease to 1 inch below the bend of the elbow.

2. Cotton wadding, 4 inches, or webril 3 inches, is applied, overlapping about one/half the width of each turn.

3. Padding is placed over the styloid of the ulna.

4. Two 3 inch rolls of plaster of paris are applied, from the distal end of the knuckles and the distal palmar crease to 1 inch below the bend of the elbow, overlapping about one/half the width of each turn. A tuck is made at the back of the plaster, the stockinet should be folded back over the top of the plaster to protect the skin from any rough edges of the plaster.

NOTES: Explain that the splint is optional.

5. Apply splint anteriorly with area cut for thumb from distal palmar crease to 1 inch below bend of elbow.

6. 3 inch plaster is used to tie-in splint.

QUESTION: What is the cast knife used for?

ANSWER: To trim cast.

7. To permit normal function of the thumb and fingers, the plaster is trimmed away from the thumb, to the distal palmar crease on the inside of the hand, and to the metacarpal joints of the knuckles on the back of the hand. The thumb should have freedom of movement around the base, and the patient should be able to touch the thumb with all the fingers.

E. Questions from students.

III. SUMMARY: (1 MIN)

A. Review of main points.

1. Definition of a cast.
2. State the purpose of a short arm cast.
3. List materials needed to apply a short arm cast.
4. After practice, perform the proper procedures in applying a short arm cast.

B. Closing statement - During this period we demonstrated the proper procedures in applying the short arm cast. Applying cast on patients properly in the future will eliminate the fears of the patient.

BROOKE ARMY MEDICAL CENTER
DEPARTMENT OF SURGERY
ORTHOPAEDIC SPECIALIST COURSE

DEMONSTRATION GUIDELINES

OBJECTIVES

1. State the definition of a cast.
2. State the purpose of a short arm cast.
3. List the materials needed to apply a short arm cast.
4. After practice, perform the proper procedures in applying a short arm cast.

A. Definition - A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing it to harden.

B. Purpose - Short arm casts are used for sprains, dislocations, and fractures below the elbow. It is used also for post-op patients.

C. Materials

1.
2.
3.
4.
5.
6.
7.
8.

D. Procedures

1. Stockinet, 3 by 18 inches is applied with a hole cut for the thumb from the distal end of the knuckles and the distal palmar crease to 1 inch below the bend of the elbow.
2. Cotton wadding, 4 inches, or webril 3 inches, is applied, overlapping about one-half the width of each turn.
3. Padding is placed over the styloid of the ulna.
4. Two 3 inch roles of plaster of paris are applied, from the distal end of the knuckles and the distal palmar crease to 1 inch below the bend of the elbow, overlapping about one-half the width of each turn. A tuck is made at the back of the arm and rubbed smooth. Before wrapping the last turn of the plaster, the stockinet should be folded back over the top of the plaster to protect the skin from any rough edges of the plaster.

NOTE: Explain that the splint is optional.

5. Apply splint anteriorly with area cut for thumb from distal palmar crease to 1 inch below bend of elbow.
6. 3 inch plaster is used to tie-in splint.

QUESTION: What is the cast knife used for?

ANSWER: To trim cast.

7. To permit normal function of the thumb and fingers, the plaster is trimmed away from the thumb, to the distal palmar crease on the inside of the hand, and to the metacarpal joints of the knuckles on the back of the hand. The thumb should have freedom of movement around the base, and the patient should be able to touch the thumb with all the fingers.

SUBJECT: Russells Traction (Skin)
INSTRUCTOR:
DIVISION: Orthopaedic Service

I. INTRODUCTION: (1 MIN)

A. Opening Statement - As Orthopaedic Specialist you will be required to apply traction on patients. You will not be able to perform this task sufficieintly if you do not know the job which is to be performed. This demonstration is to prepare you with this knowledge needed to perform this task with ease and with the utmost of efficiency.

B. Objectives

1. State the definition of Russell's Traction.
2. State the purpose of Russell's traction.
3. List the equipment used in applying Russell's traction.
* 4. After practice, perform the proper procedures in applying Russell's traction.

C. Class procedures and lesson tie-in.

1. Your previous class you were taught the uses of Russell's traction.
2. This demonstration relates to practical exercises and later clinical performances.

II. EXPLANATION/DEMONSTRATION: (28 MIN)

A. Definition

Question: What is traction?

Answer: It is a technique which is used as an aid in reducing fractures and in relieving muscle spasm and pain. It is an exertion of pull which can be accomplished by means of traction apparatus, by manual means, or by a combination of the two.

B. Purpose

Question: Why do we use Russell's traction?

Answer: Russell's traction is used in treatment of fractures of the femur, and fractures of the hip, and affections of the spine.

C. Equipment

1. Foam straps
2. Ace bandage
3. Spreader bar
4. Traction rope
5. Three pulleys
6. Weight bag

7. Weight 5-8 lb.
8. One canvas sling with two eyes and each end.

D. Procedures

1. Foam straps are applied medially and laterally to the lower limb.
2. Ace bandage is wrapped from the distal end up the leg not covering the head of the fibula.
3. Canvas sling is placed under and just below the knee and the spreader is hooked into the canvas sling.
4. The rope is threaded through the loop in the spreader, a knot tied in the end of the rope, and the rope is secured with a slipknot.
5. Rope is run through the pulley at the top of the frame, just above the knee, then through the pulley at the foot of the bed on top of the bar. It is continued to the pulley at the back of the foot plate, then to the pulley at the foot of the bed at the bottom of the bar. Bags of weights are secured at the end of the rope, clear of the floor.
6. The lower leg is placed on pillows, so that there is about a 150 degree bend in the knee. The heel should be free.
7. The foot of the bed is elevated several inches.
8. The patient is aligned with and made as comfortable as possible.

QUESTION: What is used to hold the foam straps to lower limb?

ANSWER: Ace bandage.

QUESTION: Why do you use the spreader bar?

ANSWER: To hold the foam strap away from the ankle.

E. Questions from students.

III. Summary (1 MIN)

A. Review of main points

1. Definition of Russell's traction
2. Purpose of Russell's tractions
3. List equipment used in applying Russells traction
4. After practices, perform the proper procedures in applying Russell's traction.

B. Closing Statement. During this demonstration, you were taught the proper procedures in applying Russell's tractions. In the future you will be applying traction on patients. Their chances of healing properly depends on you.

ORTHOPAEDIC SPECIALIST COURSE

DEMONSTRATION GUIDELINES

Russell's Tractions

OBJECTIVES

1.
2.
3.
*4.

A. Definition
B. Purpose
C. Equipment

    1.
    2.
    3.
    4.
    5.
    6.
    7.
    8.

D. Procedures.

1. Foam straps are applied medially and laterally to the lower limb.
2. Ace bandage is wrapped from the distal end up the leg not covering the head of the fibula.
3. Canvas sling is placed under and just below the knee and the spreader is hooked into the canvas sling.
4. The rope is threaded through the loop in the spreader, a knot tied in the end of the rope, and the rope is secured with a slipknot.
5. Rope is run through the pulley at the top of the frame, just above the knee, then through the pulley at the foot of the bed on top of the bar. It is continued to the pulley at the back of the foot plate, then to the pulley at the foot of the bed at the bottom of the bar. Bags of weights are secured at the end of the rope, clear of the floor.
6. The lower leg is placed on pillows, so that there is about a 150 degree bend in the knee. The heel should be free.
7. The foot of the bed is elevated several inches.
8. The patient is alined with and made as comfortable as possible.

SUBJECT: Long Arm Cast
INSTRUCTOR:
DIVISION: Orthopaedic Service

I. INTRODUCTION: (3 MIN)

A. Opening Statement - This demonstration is to better acquaint you with the proper techniques in applying the long arm cast, long arm cylinder cast, long arm navicular cast, and long arm hanging cast. By applying these techniques properly the patients will have more confidence in your ability to apply a long arm cast.

B. OBJECTIVES

1. State the definition of a cast.
2. State the purpose of a long arm cast.
3. List the materials needed in applying a long arm cast.
*4. After practice, perform the proper techniques in applying a long arm cast.

C. Class procedures and lesson tie-in.

1. Your previous class you were taught the uses of long arm casts.
2. This demonstration relates to practical exercises and later clinical performance.

*TERMINAL OBJECTIVE

II. EXPLANATION/DEMONSTRATION: (35 MIN)

A. Definition

QUESTION: What is a cast?

ANSWER: A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing the plaster to harden.

B. Purpose

QUESTION: Why do we use the long arm cast?

ANSWER: Long arm casts are used for sprains, dislocations, and fractures of the arm and forearm and also post-op patients.

C. Materials

1. Stockinet. 3 by 28 inches
2. Cotton wadding. 4 inches or Webril 3 inches.
3. Padding.
4. Six 3 inch rolls of plaster bandage.
5. Water 70 - 80 degrees
6. Splint. Optional.

7. Scissors
8. Cast knife.

D. Procedures

1. Stockinet 3 by 28 inches is applied with a hole cut for thumb from the distal end of the knuckles and the distal palmar crease to about 2 inches from the axilla.

   The elbow is flexed to 90 degree angle. The wrist is in a 45 degree cock-up position, with the back of the thumb toward the ceiling and the hand in a position of function.

2. Cotton padding, 4 inches, or Webril 3 inches is applied, overlapping about 1/2 the width of each turn.

3. Padding is placed over the styloid of the ulna, the elbow.

4. Five 3 inch rolls of plaster of paris are applied from the distal end of the knuckles and the distal palmar crease to about 2 inches from the axilla, overlapping about 1/2 the width of each turn. A tuck is made at the back of the plaster, the stockinet should be folded back over the top of the plaster to protect the skin from any rough edges of the plaster.

NOTES: Explain that the splint is optional. A short wide splint is applied posteriorly and tied in with plaster roll.

QUESTION: What is the cast knife used for?

ANSWER: To trim cast.

5. To permit normal function of the thumb and fingers, the plaster is trimmed away from thumb, to the distal palmar crease on the inside of the hand, and to the metacarpal joints of the knuckles on the back of the hand. The thumb should have freedom of movement around the base, and the patient should be able to touch the thumb with all fingers.

E. Questions from students.

III. SUMMARY: (1 MIN)

A. Review of main points.

1. Definition of a cast.
2. State the purpose of a long arm cast.
3. List materials needed to apply a long arm cast.
4. After practice, perform the proper procedures in applying a long arm cast.

B. Closing statement - During this period we demonstrated the proper procedures in applying the long arm cast. Applying cast on patients properly in the future will eliminate the fears of the patient.

DEMONSTRATION GUIDELINES

OBJECTIVES

1. State the definition of a cast.
2. State the purpose of a long arm cast.
3. List the materials needed to apply a long arm cast.
4. After practice, perform the proper procedures in applying a long arm cast.

A. Definition - A cast is a negative imprint of a body part made by applying plaster of paris to the part and allowing it to harden.

B. Purpose - Long arm cast is used for sprains, dislocations, and fractures of the arm and forearm. It is used also for post-op patients.

C. Materials

1.
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8.

D. Procedures

1. Stockinet 3 by 28 inches is applied with a hole cut for the thumb from the distal end of the knuckles and the distal palmar crease to 2 inches from the axilla.
2. Cotton wadding 4 inches, or Webril 3 inches is applied overlapping about 1/2 the width of each turn.
3. Padding is placed over the elbow and styloid of the ulnar.
4. Five 3 inch rolls of plaster of paris are applied from the distal end of the knuckles and the distal palmar crease to 2 inches from the axilla, overlapping about 1/2 the width of each turn.

   A tuck is made at the back of the arm and rubbed smooth. Before wrapping the last turn of plaster, the stockinet should be folded back over the top of the plaster to protect the skin from any rough edges of the plaster.

NOTE: Explain that the splint is optional.

5. Apply splint - A short wide splint is applied posteriorly and tied in with plaster roll.

QUESTION: What is the cast knife used for?

ANSWER: To trim cast.

(2)

6. To permit normal function of the thumb and fingers, the plaster is trimmed away from the thumb to the distal palmar crease on the inside of the hand and to the metacarpal joints of the knuckles on the back of the hand.

The thumb should have freedom of movement around the base, and the patient should be able to touch the thumb with all the fingers.

SUBJECT: Bucks Traction
INSTRUCTOR:
DIVISION: Orthopaedic Service

I. INTRODUCTION: (1 MIN)

A. Opening Statement - As Orthopaedic Specialist you will be required to apply traction on patients. You will not be able to perform this task sufficiently if you do not know the job which is to be performed. This demonstration is to prepare you with the knowledge needed to perform this task with ease and with the utmost of efficiency.

B. OBJECTIVES

1. State the definition of Bucks Traction.
2. State the purpose of Bucks Traction.
3. List the equipment used in applying Bucks Traction.
*4. After practice, perform the proper procedures in applying Bucks Traction.

C. Class procedures and lesson tie-in.

1. Your previous class you were taught the uses of Bucks Traction.
2. This demonstration relates to practical exercises and later clinical performances.

*TERMINAL OBJECTIVE

II. EXPLANATION/DEMONSTRATION: (28 MIN)

A. Definition

QUESTION: What is traction?

ANSWER: It is a technique which is used as an aid in reducing fractures and in relieving muscle spasm and pain. It is an exertion of pull which can be accomplished by means of traction apparatus, by manual means, or by a combination of the two.

B. Purpose

QUESTION: Why do we use Bucks traction?

ANSWER: Bucks traction is used in the treatment of affections of the spine, the upper limbs, and the lower limbs.

C. Equipment

1. Foam straps.
2. Ace bandage.
3. Spreader bar.
4. Traction rope.
5. Pulley.
6. Weight bag.
7. Weights 5-10 pounds.

D. Procedures

1. Foam straps are applied medially and laterally to the lower limb.
2. Ace bandage is wrapped from the distal end up the leg not covering the head of the fibula.
3. Spreader bar is attached to the foam straps.
4. Traction rope is treaded through the spreader bar and a knot is tied to the end.
5. Pulley is attached to the orthopaedic bed.
6. Weight bag is tied to the opposite end of the traction rope.
7. Weights are placed in the weight bag.

QUESTION: What is used to hold the foam straps to the lower limb?

ANSWER: Ace bandage.

QUESTION: Why do you use the spreader bar?

ANSWER: To hold the foam strap away from the malleoli (ankle).

E. Questions from students.

III. SUMMARY (1 MIN)

A. Review of main points

1. Definition of Bucks Traction.
2. Purpose of Bucks Traction.
3. List equipment used in applying Bucks Traction.
4. After practice, perform the proper procedures in applying Bucks Traction.

B. Closing statement - During this demonstration you were taught the proper procedures in applying Bucks Traction. In the future you will be applying traction on patients. Their chances of healing properly depends on you.

BROOKE ARMY MEDICAL CENTER
DEPARTMENT OF SURGERY
ORTHOPAEDIC SPECIALIST COURSE

DEMONSTRATION GUIDELINES

OBJECTIVES

1.

2.

3.

* 4.

A. Definition

B. Purpose

C. Equipment

1.

2.

3.

4.

5.

6.

7.

D. Procedures

1. Foam straps are applied medially and laterally to the lower limb.

2. Ace bandage is wrapped from the distal end up the leg not covering the head of the fibula.

3. Spreader bar is attached to the foam straps.

4. Traction rope is threaded through the spreader bar and a knot is tied to the end.

5. Pulley is attached to the end of the bed.

6. Weight bag is tied to the opposite end of the traction rope.

7. Weights are placed in the weight bag.

Situation 1:

You have received orders to prepare the skin for a patient who is scheduled for an operation.

1. Refer to Situation 1:
   A patient is scheduled for surgery of the forearm. You must:
   (a) prep from the tip of the finger to the elbow and manicure
   (b) prep from the wrist to the axilla and manicure.
   (c) prep from the tip of the fingers to the axilla and manicure.
   (d) prep from the hand to the shoulder.

2. Refer to Situation 1:
   You have a patient who is having an operation of the foot. You must prep from the:
   (a) tip of the toes to perineum and pedicure.
   (b) tip of the toes to include the perineal
   (c) tip of the toes to knee and pedicure.
   (d) from ball of the foot to above the knee.

3. Refer to Situation 1:
   A patient is to have neck surgery. You must prep:
   (a) upper back above waist, back of neck and scalp to upper level of ears.
   (b) waist, back of neck and scalp to lover level of ears.
   (c) back of neck and scalp to upper level of ears.
   (d) entire head, back of neck to shoulder level.

4. The skeletal of the foot is made up of which of the following bones:
   (a) metatarsals, metacarpals, phalanges.
   (b) phalanges, metacarpals, metatarsals.
   (c) tarsals, metatarsals, metacarpals.
   (d) tarsals, metatarsals, phalanges.

5. After reading a patient's x-rays, the physician orders a cast for a Moore's fracture. You should set up for which type of cast?
   (a) long leg
   (b) long arm
   (c) short leg
   (d) short arm

6. A doctor has ordered a cast for a Gosselin's fracture. You should set up for which type of cast?
   (a) long leg
   (b) long arm
   (c) short leg
   (d) short arm

7. You have been ordered to set up materials for a Monteggin's fracture. You must set up for which type of cast?
   (a) long leg
   (b) short leg
   (c) long arm
   (d) short arm

8. When instructing a patient who has a freshly applied cast, you should warn him that the cast will not be dry and hard for how many hours?

    (a) 48
    (b) 24
    (c) 12
    (d) 6

9. When using a metal cradle dryer, you must insure that the light bulbs are no larger than:

    (a) 25 watts
    (b) 50 watts
    (c) 75 watts
    (d) 100 watts

10. You are using a dryer to dry an extremity cast. How long must you wait before you apply the heat?

    (a) 4 min.
    (b) 6 min.
    (c) 8 min.
    (d) 10 min.

11. Volkmann's contracture is most likely to occur when a patient has swelling with a fracture of the:

    (a) forearm with a long arm cast in 90-deg. flexion.
    (b) mid shaft of the tibia with a long leg cast with 15-deg. bend at the knee.
    (c) elbow with a long arm cast in acute flexion.
    (d) humerus with a hanging long arm cast.

12. To prevent hyperextension of patient's knee, you should place a small pillow on the uninvolved leg under the:

    (a) heel
    (b) thigh
    (c) knee
    (d) calf.

13. You are assisting a doctor who is applying a Minerva jacket. You should insure that the neck is positioned so that:

    (a) it is in a neutral position.
    (b) the mandible is close to the sternum.
    (c) it is in hyperflexion.
    (d) it is in hyperextension.

14. When using the normal procedure of drying a cast, you should:

    (a) use a commercial dryer with heat control.
    (b) use a metal cracle with 50 watt bulb.
    (c) expose the cast to the air at room temperature.
    (d) cover cast with blanket.

15. Where should you place a pillow to prevent pressure on the edges of the cast on a patient in a body spica who has the head of his bed elevated?

    (a) under the upper part of his cast.
    (b) under his head.
    (c) under the lumbosacral area.
    (d) under each arm.

16. When applying a long leg cast, you should overlap each succeeding turn by:

    (a) ½ to 1 inch.
    (b) 3½ to 4 inches.
    (c) 1½ to 3 inches.
    (d) 4½ to 5 inches.

17. When dipping a plaster bandage roll in a bucket of water, you should insure that the water temperature is:

    (a) 50 to 60 degrees
    (b) 70 to 80 degrees
    (c) 85 to 90 degrees
    (d) 90 to 100 degrees

18. Which muscle is used to flex the arm?

    (a) trapezius
    (b) brachii radialis
    (c) biceps
    (d) pectoralis major

19. In which one of the following areas does the deltoid muscle originate?

    (a) at the cervical spine
    (b) at the greater trochanter
    (c) over the acromioclavicular joint
    (d) over the sternum tuberosity

20. When the leg is moved laterally from the body, the hip is in the position of:

    (a) dorsiflexion
    (b) flexion
    (c) adduction
    (d) abduction

21. Muscles are attached to bones by means of:

    (a) cartilage
    (b) ligaments
    (c) tendons
    (d) fascia

22. What muscles are involved in wrist drop?

    (a) extensors
    (b) flexors
    (c) supinators
    (d) pronators

23. Your NCOIC has ordered you to set up materials for a Velpeau cast. You should set up:

    (a) stockinet, Webril, three 6 in. plaster rolls
    (b) stockinet 10" x 24", pads, Webril, and eight to nine 6 in. plaster rolls
    (c) stockinet 10" x 24", pads, cotton wadding, and three 6 in. plaster rolls
    (d) stockinet 10" x 10", pads, six 6 in. plaster rolls, Webril

24. You are converting a long leg cast into a walking cast by adding a walking heel. You must first lay a foundation for the heel by using a:

    (a) five thickness long splints folded twice and tied in with a plaster roll.
    (b) eight thickness short splints folded twice and tied in with a plaster roll.
    (c) six inch plaster roll
    (d) four inch plaster roll

25. After the application of a short arm cast, a physician orders a triangular bandage sling. In which position should you place the patient's forearm:

    (a) level with the elbow
    (b) waist level
    (c) slightly above the level of the elbow
    (d) pointing towards the shoulder.

ORTHOPAEDIC CAST
STUDENT TEST

1. The function of the biceps muscle is to produce:
   - A. Adduction
   - B. Abduction
   - C. Extension
   - D. Flexion

2. The bones which form the tip of the spine fuse into one at adulthood. The bone resulting from this fusion is known as the:
   - A. Sacrum
   - B. Coccyx
   - C. Itium
   - D. Calcaneus

3. In which one of the following areas does the deltoid muscle originate?
   - A. At the cervical spine.
   - B. At the greater trochanter.
   - C. Over the acromeoclavecular joint.
   - D. Over the sternum tuberosity.

4. When the leg is moved laterally from the body, the hip is in the position of:
   - A. Dorsiflexion
   - B. Flexion
   - C. Adduction
   - D. Abduction

5. The malleous is located at which of the following joints?
   - A. Elbow
   - B. Ankle
   - C. Wrist
   - D. Knee

6. The three cunciform bones in the foot are located in the:
   - A. Toes
   - B. Sole
   - C. Heel
   - D. Instep

7. Muscle are attached to bones by means of:
   - A. Cartilage
   - B. Ligaments
   - C. Tendons
   - D. Fascia

8. What muscles are involved in wrist drop?
   - A. Extensors
   - B. Pronators
   - C. Supinators
   - D. Flexors

9. What muscle is used to flex the arm?
   A. Biceps
   B. Brapezins
   C. Brachii radialis
   D. Pectoralis major

10. The term patella refers to what body part?
   A. Fibula
   B. Armpit
   C. Thigh bone
   D. Knee cap

11. Which term is used when the forearm is turned so as the palm is up?
   A. Eversion
   B. Inversion
   C. Supination
   D. Pronation

12. Which term is used when the sole of the foot is turned inwards?
   A. Inversion
   B. Eversion
   C. Pronation
   D. Plantar flexion

13. The skeleton of the foot is made up of which of the following?
   A. Metatarsals, metacarpals, phalanges
   B. Phalanges, metacarpals, metatarsals
   C. Tarsals, metatarsals, metacarpals
   D. Tarsals, metatarsals, phalanges

14. Which of the following is the LONGEST bone of the body?
   A. Femur
   B. Tibia
   C. Fibula
   D. Humerus

15. The points at which bones come together are known as:
   A. Condyles
   B. Ramus
   C. Joints
   D. Digits

16. The spine has what number of normal curvatures?
   A. Two
   B. Five
   C. Three
   D. Four

17. The ankle and foot motion takes place in four directions - up, down, inward, and outward. How many muscles perform these actions?
   A. 2
   B. 4
   C. 6
   D. 8

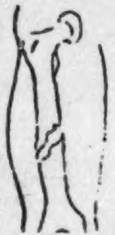
18. What is the anterior portion of a vertebra called?
    A. Foramen
    B. Body
    C. Arch
    D. Disk

19. How many phalanges are in a hand?
    A. 8
    B. 10
    C. 12
    D. 14

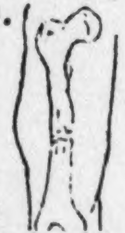
20. Which of the following are the Red blood cells?
    A. Leukocytes
    B. Erythrocytes
    C. Thrombocytes
    D. Saprophytes

21. Which one of the following figures ia a transverse fracture?

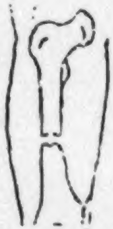
A.



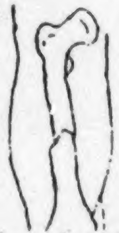
B.



C.



D.



22. When the normal relationship of a joint is completely displaced and remains so, this condition is known as a:
    A. Strain
    B. Dislocation
    C. Sprain
    D. Disarticulation

23. The amputation through the mallioli; proximal to the distal articular surface to the tibia, is called a:
    A. Lisfranc torso metatarsal
    B. Chopart midtarsal
    C. BK (below knee)
    D. Symes

24. What is the setting time for extra fast plaster bandage?
    A. 2 to 4 minutes
    B. 3 to 5 minutes
    C. 5 to 8 minutes
    D. 8 to 10 minutes

25. When dipping a plaster bandage roll in a bucket of water, what is the water temperature?
    A. 50 to 60 degrees
    B. 70 to 80 degrees
    C. 80 to 90 degrees
    D. 90 to 100 degrees

26. When bivalving a short arm cast, which sides should you cut?
    A. Lateral and radial
    B. Ulnar and radial
    C. Posterior and anterior

27. In the application of a standard short arm cast, how many rolls (in inches) of plaster should you use?
    A. Three 3 inch
    B. Two 4 inch
    C. Four 2 inch
    D. One 6 inch

28. What is a sugar tong splint applied for?
    A. Fracture radius
    B. Fracture humerus
    C. Fracture navicular
    D. Fracture metacarpal

29. What type of cast is applied for a fractured humerus?
    A. Long arm navicular
    B. Standard long arm
    C. Long arm cylinder
    D. Long arm hanging

30. There are eight (8) carpal bones in the wrist. Name the eight bones.
    1.
    2.
    3.
    4.
    5.
    6.
    7.
    8.

31. In applying a long leg cast, how far up should you extend this cast from the pubic area?
    A. 2 inches
    B. 3 inches
    C. 4 inches
    D. 5 inches

32. In applying a short arm navicular cast (thumb spica), how should the thumb be placed?
    A. Position of function
    B. Opposite the index finger
    C. Best position for the patient
    D. 15 degrees cock-up with the thumb toward the ceiling.

33. If a patient has a fracture of the radius and the doctor asked you to apply traction, what type would you apply?
    A, Balanced suspension
    B. Dunlop
    C. Right angle skeletal
    D. Bryant's traction

34. The doctor wants you to set up a traction that has a double-weight and a single-pulley system, which type of traction should you set up?
    A. Balanced suspension with skin traction
    B. Russell's traction
    C. Buck's traction
    D. Thomas splint and Pearson attachment

35. Which term is used when the forearm is turned so as the palm is up?
    A. Eversion
    B. Inversion
    C. Supination
    D. Pronation

Test #2

1. In which one of the following areas does the deltoid muscle originate?
   A. At the cervical spine
   B. At the greater trochanter
   C. Over the seromeoclavecular joint
   D. Over the sternum tuberosity

2. When the leg is moved laterally from the body, the hip is in the position of:
   A. Dorsiflexion
   B. Flexion
   C. Adduction
   D. Abduction

3. The malleolus is located at which of the following joints?
   A. Elbow
   B. Ankle
   C. Wrist
   D. Knee

4. The three cunciform bones in the foot are located in the?
   A. Toes
   B. Sole
   C. Heel
   D. Instep

5. What muscles are absent in wrist drop?
   A. Extensors
   B. Pronators
   C. Supinators
   D. Flexors

6. The term patella refers to what body part?
   A. Fibula
   B. Armpit
   C. Thigh bone
   D. Knee cap

7. Which term is used when the forearm is turned so as the palm is up?
   A. Eversion
   B. Inversion
   C. Supination
   D. Pronation

8. The skeleton of the foot is made up of which of the following?
   A. Metatarsals, metacarpals, phalanges
   B. Phalanges, metacarpals, metatarsals
   C. Tarsals, metatarsals, metacarpals
   D. Tarsals, metatarsals, phalanges

9. The spine has what number of normal curvatures?
   A. Two
   B. Five
   C. Three
   D. Four

10. The ankle and foot motion takes place in four directions, up, down, inward, and outward. How many muscles perform these actions?
   A. 2
   B. 4
   C. 6
   D. 8

11. How many phalanges are in a hand?
   A. 5
   B. 10
   C. 12
   D. 14

12. Which of the following are the Red Blood Cells?
   A. Leukocytes
   B. Erythrocytes
   C. Thrombocytes
   D. Saprophytes

13. When the normal relationship of a joint is completely displaced and remains so, this condition is known as?
   A. Strain
   B. Dislocation
   C. Sprain
   D. Disarticulation

14. The amputation through the mallioli, proximal to the distal articular surface to the tibia, is called a?
   A. Lisfranc torso metatarsal
   B. Chopart midtarsal
   C. BK (below knee)
   D. Symes

15. What is the setting time for extra fast plaster bandage?
   A. 2 to 4 minutes
   B. 3 to 5 minutes
   C. 5 to 8 minutes
   D. 8 to 10 minutes

16. When dipping a plaster bandage roll in a bucket of water, what is the water temperature?
   A. 50 to 60 degrees
   B. 70 to 80 degrees
   C. 80 to 90 degrees
   D. 90 to 100 degrees

17. What is a sugar tong splint applied for?
    - A. Fracture radius
    - B. Fracture humerus
    - C. Fracture navicular
    - D. Fracture metacarpal

18. There are eight (8) carpal bones in the wrist. Name the eight bones.
    - A.
    - B.
    - C.
    - D.
    - E.
    - F.
    - G.
    - H.

19. If a patient has a fracture of the radius and the doctor asked you to apply traction, what type would you apply?
    - A. Balanced suspension
    - B. Dunlop
    - C. Right angle skeleton
    - D. Bryant's traction

20. What is the anterior portion of a vertabra called?
    - A. Foramen
    - B. Body
    - C. Arch
    - D. Disk

1. Which term is used when the forearm is turned so as the palm is up?

   a. Eversion
   b. Inversion
   c. Supination
   d. Pronation

2. When bivalving a short arm cast, which sides should you cut?

   a. Lateral and medial
   b. Ulna and radial
   c. Posterior and anterior

3. There are 9 different types of fractures listed on page 53 of your 8.231. Name five of them.

   a.
   b.
   c.
   d.
   e.

4. How many phalanges are in a hand?

   a. 14
   b. 8
   c. 10
   d. 12

5. What is the setting time for extra fast plaster bandages?

   a. 2 to 4 minutes
   b. 3 to 5 minutes
   c. 5 to 8 minutes
   d. 8 to 10 minutes

6. The term patella refers to what body part?

   a. Armpit
   b. Thigh bone
   c. Knee cap
   d. Fibula

7. Which term is used when the sole of the foot is turned inwards?

   a. Eversion
   b. Pronation
   c. Inversion
   d. Plantar flexion

8. The spine has what number of normal curvatures?

   a. 2
   b. 3
   c. 4
   d. 5

9. Which muscle is used to flex the arm?

   a. triceps
   b. biceps
   c. thigh

10. The points at which bones come together are known as...

    a. digets
    b. joints
    c. condyles
    d. Greater Tuberosity

11. Which of the following is the longest bone of the body?

    a. tibia
    b. fibula
    c. femur
    d. humerus

12. The hand is made up of metacarpals and phalanges. How many bones are there?

    a. 8 and 12
    b. 5 and 14
    c. 5 and 12
    d. 12 and 6

13. Muscles are attached to bones by means of ...

    a. ligaments
    b. cartilage
    c. tendons
    d. tissue

14. Which muscles are involved in wrist drop?

    a. pronatars
    b. flexors
    c. extensors

15. Bryant's traction is used to treat fractures of a femur in what age group?

    a. adults
    b. middle age
    c. children
    d. young children

16. What is a Sugar Tong splint applied for?

    a. Px humerus
    b. Px radius
    c. Px navicular

17. There are 9 carpal bones in the wrist. Name them.

    a.
    b.
    c.
    d.
    e.
    f.
    g.
    h.

18. What type of cast is applied for a fractured humerus?

    a. Long arm navicular
    b. long arm cylinder
    c. Long arm hanging

19. In applying a long leg cast how far up should you extend the cast from the pubic area?

    a. 2 inches
    b. 3 inches
    c. 4 inches
    d. 6 inches

20. When the sole of the foot turns outward, what position is this called?

    a. inversion
    b. dorsiflexion
    c. oversion

Test #1

1. The bony framework of the adult human body is composed of ________ bones.

2. The hard outer shell of the bone is called ________________________?

3. Yellow marrow is composed chiefly of _______________?

4.

5. Name the 4 types of bones, A__________, B_________, C___________,
D______________?

6. Name the 9 types of joints, A________________, B____________________,
C______________, D_________________, E __________________, F_______________,
G _______________, H _______________ and I ________________?

7. A vertebral column consists of ________________ movable or true
vertebrae and a fixed vertebrae?

8. Name the true vertebrae, 7____________, 12 _______________ and
5 __________________?

9. Name the parts of the forearm?

1 ______________, 2 ______________, 3 _______________, 4_______________,
5 ______________, 6 ______________ and 7 ____________________

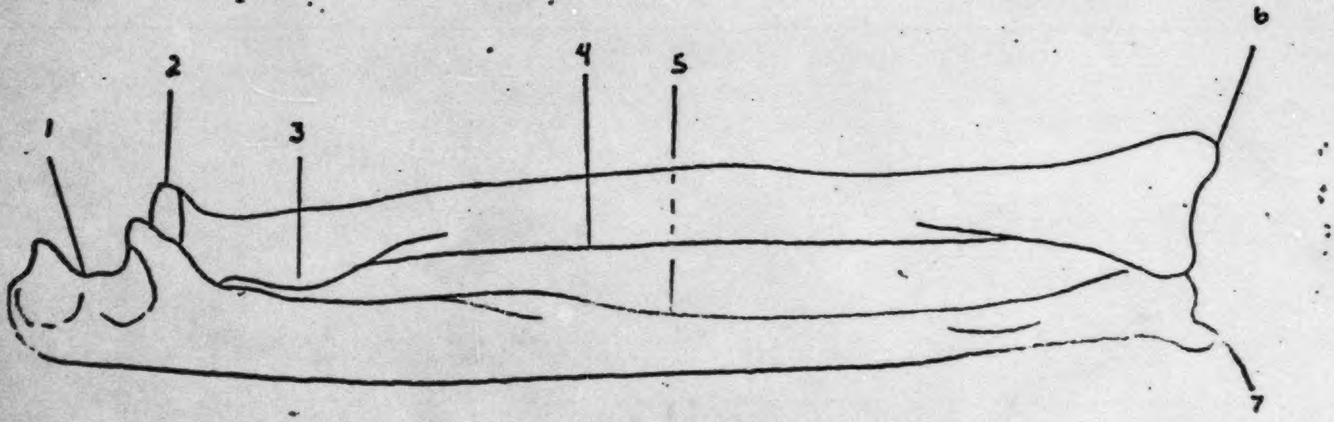


Figure 14, Forearm

Test #2

1. The clavicle is a long ______________ shaped bone.

2. The clavicle is anchored medially at the ______________________?

3. The scapula is a large roughly _______________ bone which lies against the back of the __________________.

4. The shoulder joint is a _______________ joint.

5. The ulna is on the _____________ side of the forearm.

6. The radius is on the ______________ side of the forearm.

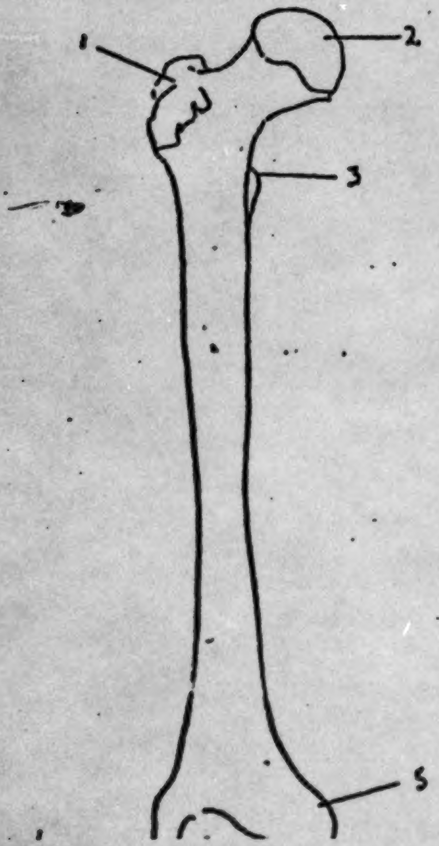
7. The hand is made up of _______________ metacarpal bones and __________ phalanges.

8. The knee joint is a modified hinge joint? (T) __ (F) __

9. Is the knee joint supported by strong ligaments (T) (F), and by very strong tendon of the _______ in which the ____________ is located.

10. The tibia lies on the ______________ side of the leg.

11. Name the parts of the femur



1_______________________

2_______________________

3_______________________

4_______________________

5_______________________

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Test #3

Name ______________________

1. The knife used in triming a cast, use a ___________________________.

2. To retard the setting time of plaster use salt in the water. T. F.

3. Plaster is made of gypsin. T. F.

4. Bivalving a cast is ___________________________________.

5. Name the body defenses against bacteria.
   a.
   b.
   c.
   d.

6. Diach control will not melt at 2420. T. F.

7. The largest pack for a autoclave should not be more than 12" by 10' by 20" T. F.

8. Lateral menisus is at ___________________________.

9. Sacrum is ______________________

10. The shoulder joint is _______________________.

11. Name the carpal bones.

12. Name the joints of the hand and wrist:

13. Name the bones of the tarsal:

14. The spinal cords extends from the medullablongata of the brain to the level of the disc between the ___________________________.

15. The part of the brain that controls muscle tone __________________________.

16. Name the kinds of muscle:

17. Skeletal muscles are attached to bone by ____________________.

18. Disease in which a joint or joints become inflamed ____________________.

19. Name the 9 types of Fractures

20. A strain is ____

Quiz #1

1. Name the two kinds of bone marrow
   1. ________________
   2. ________________

2. Name the outer shell of the bone.

   ____

3. Name the spongy, porous inner part of the bone

   ____

4. Give an example of a gliding joint.

   ____

5. Give an example of a condyloid joint.

   ____

6. Name the true vetebrae and the number of each of them

   1. ________________, 2. ____________________, 3 __________________

7. The clavicle is a long __________ shaped Bone.

8. Name the Bones of the Wrist.

   1. __________, 2. __________, 3. __________, 4. __________, 5. __________
   6. __________, 7. __________ and 8. __________

9. Name the Joints of the Hand and Wrist

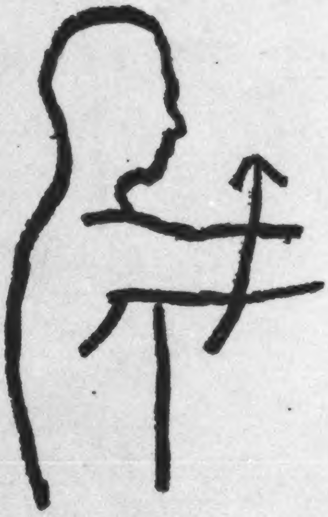
   1. __________, 2. __________, 3. __________, 4. __________ and
   5. __________

10. Name all of the bones of the hand and wrist.

    1. __________, 2. __________, 3. __________, 4. __________, 5. __________,
    6. __________, 7. __________, 8. __________, 9. __________, 10. __________,
    11. __________, 12. __________, 13. __________, 14. __________,
    15. __________, 16. __________, 17. __________, 18. __________. 19. ______,
    20. __________, 21. __________, 22. __________, 23. __________, 24. ______,
    25. __________

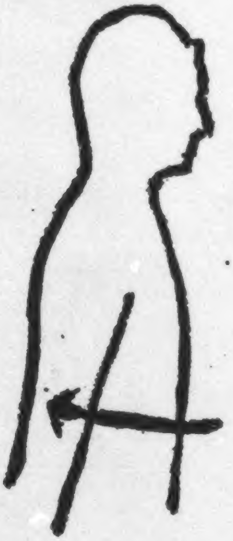
QUIZ #2

1. Yellow marrow is composed chiefly of ____________________________?
2. Name the long bone ______________________________.
3. Name the flat bone ______________________________.
4. Name a short bone ______________________________.
5. Name an irregular bone __________________________.
6. Give an example of a gliding joint ___________________________________.
7. Example of a hinge joint __________________________________.
8. Example of a ball and socket joint ___________________________________.
9. The vertebral column consists of ___________________________ movable or true vertebrae and fixed vertebrae _______________________________, and _______________________________.
10. Name the true vertebraes ______________________, ______________________, ___________________________________.
11. The _____________________________ is a long s-shaped bone.



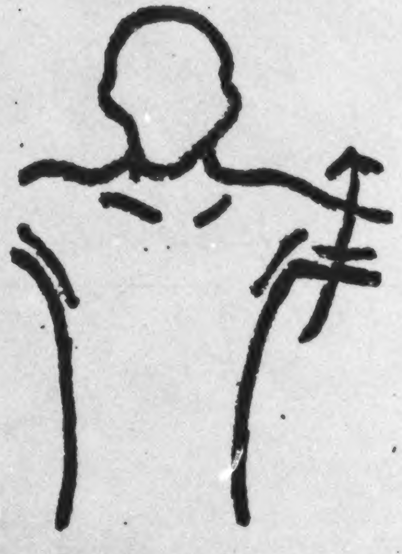
① ______

Arm moves forward



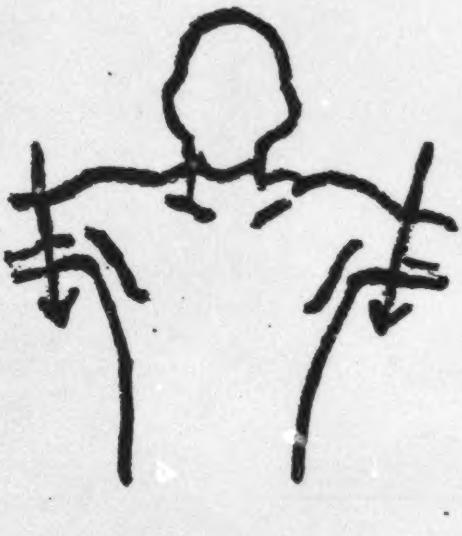
② ______

Arm moves backward



③ ______

Arm moves away from trunk carefully



④ ______

Arm moves from abduction toward trunk

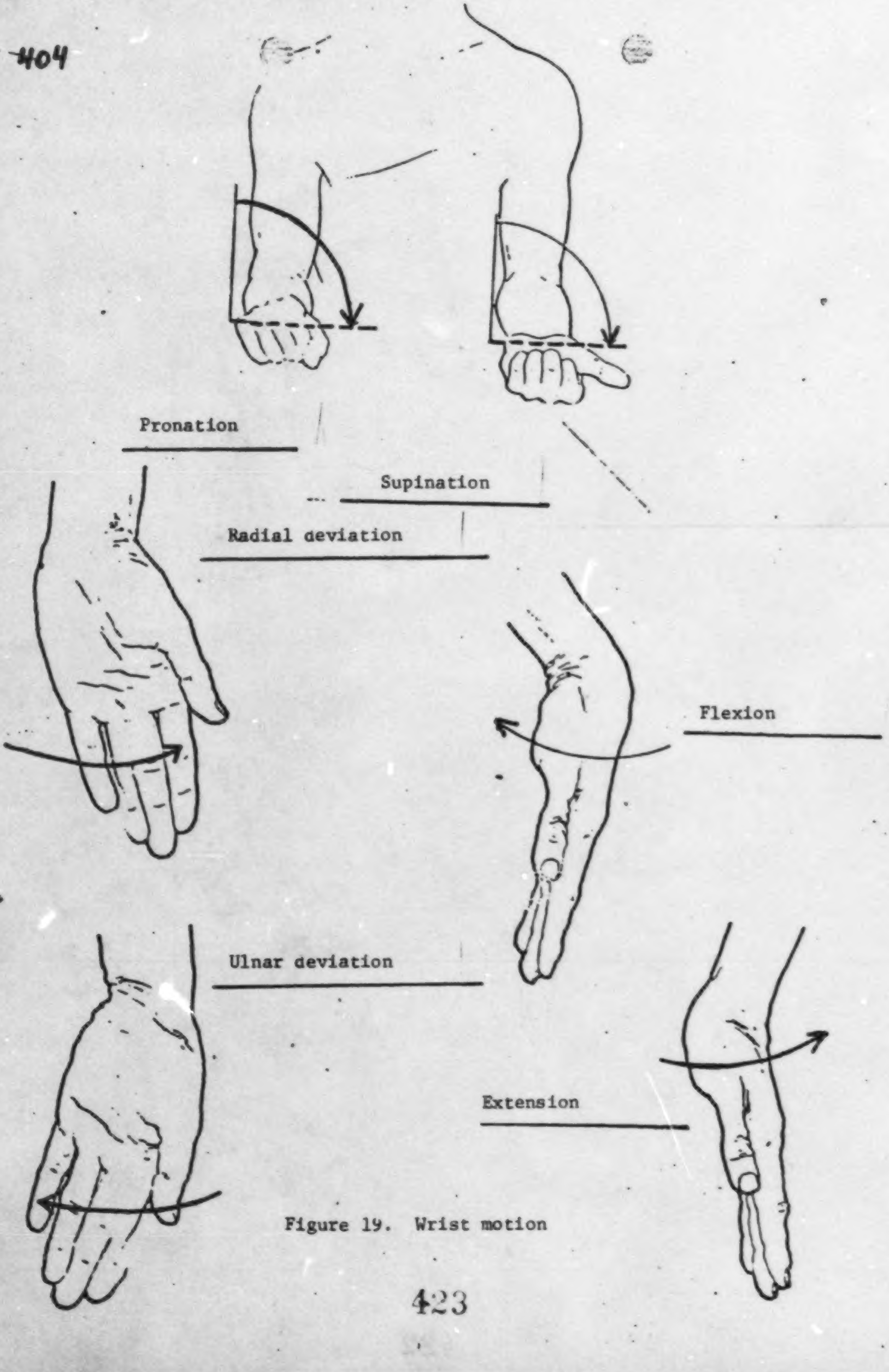

Pronation
Supination
Radial deviation
Flexion
Ulnar deviation
Extension

Figure 19. Wrist motion

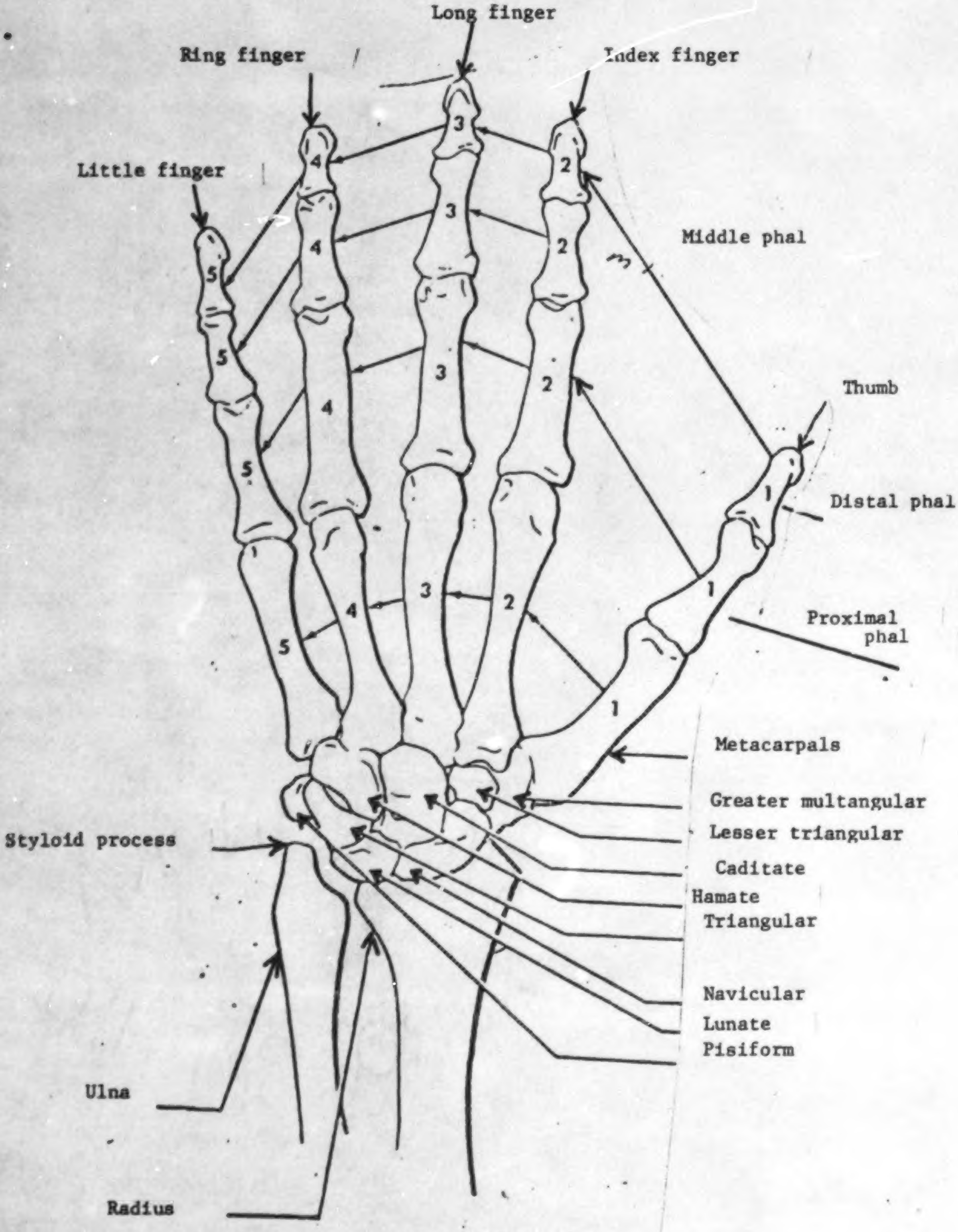
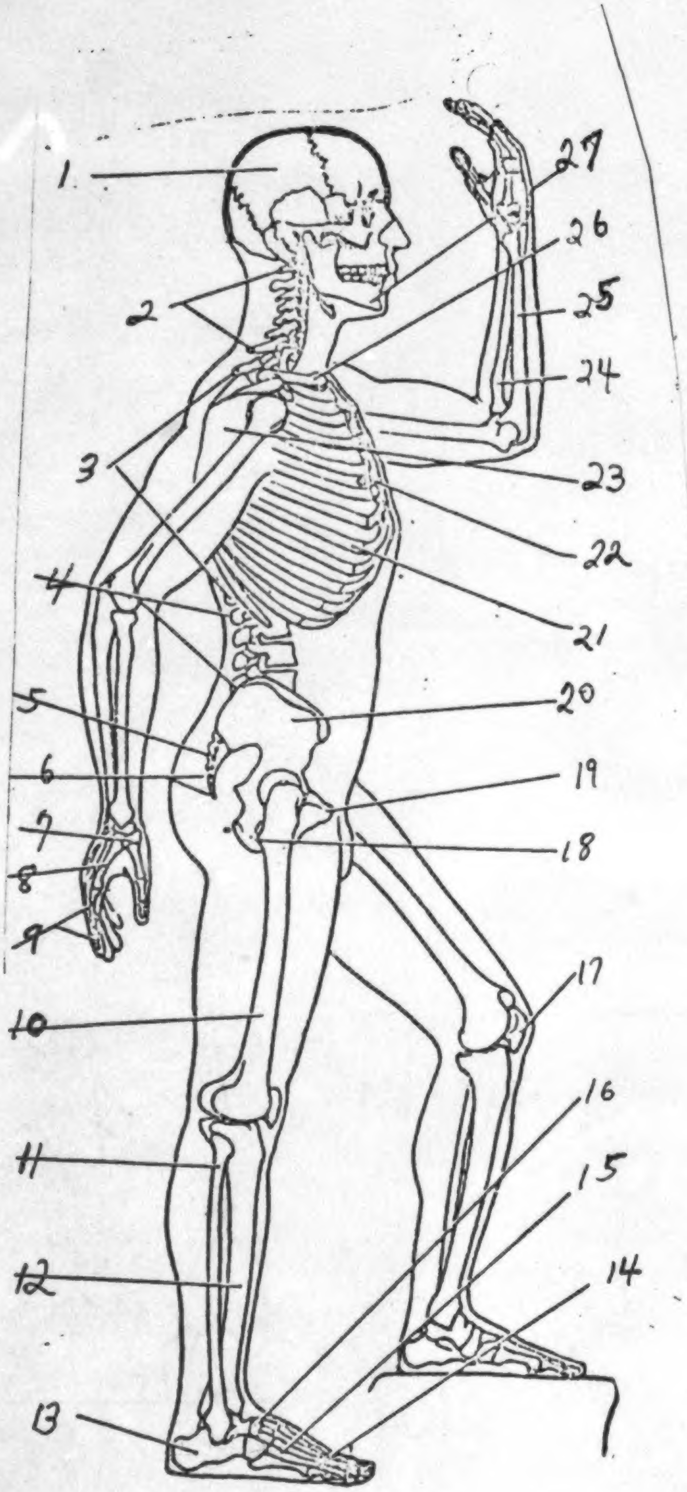

Long finger
Ring finger
Index finger
Little finger
Middle phal
Thumb
Distal phal
Proximal phal
Metacarpals
Greater multangular
Lesser triangular
Caditate
Hamate
Triangular
Styloid process
Navicular
Lunate
Pisiform
Ulna
Radius
1
2
3
4
5

Figure 17. Bones of the hand and wrist

1. Skull
2. Cervicle ver. (7)
3. Thoracic ver. (12)
4. Lubar ver. (5)
5. Sacrum
6. Coccyx
7. Carpals
8. Metacarpals
9. Phalanges
10. Femur
11. Fibula
12. Tibia
13. Calcaneous
14. Phalanges
15. Metatarsals
16. Tarsals
17. Patella
18. Ischium
19. Pubis
20. Ilium
21. Rib cage
22. Sternum
23. Scapula
24. Radius
25. Ulna
26. Clavicle
27. Mandible


1
2
3
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27

Figure 2 The skeleton, lateral view

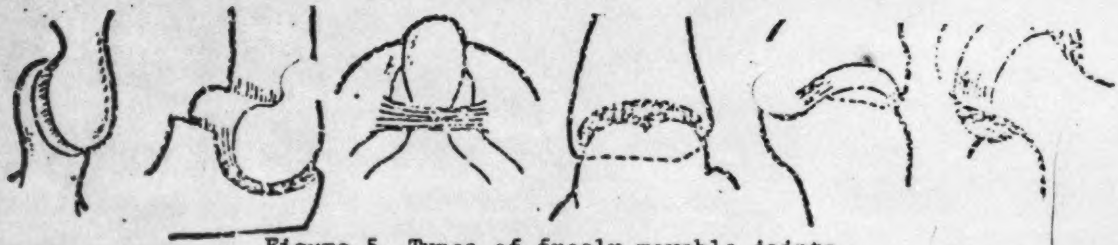
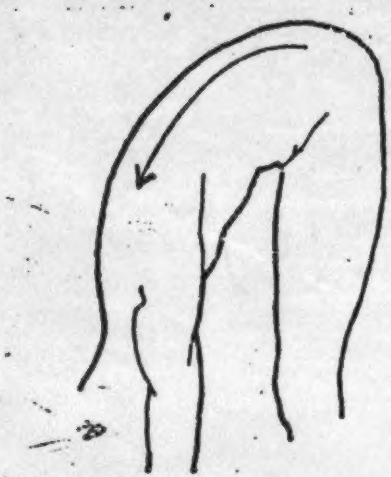
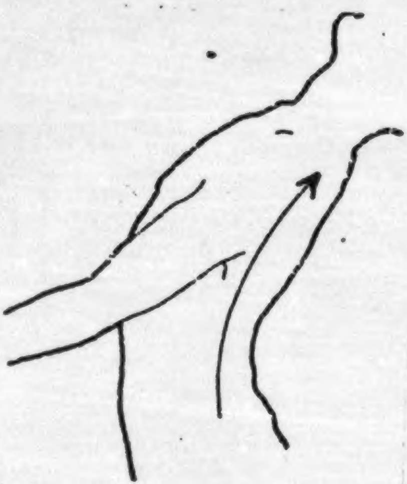


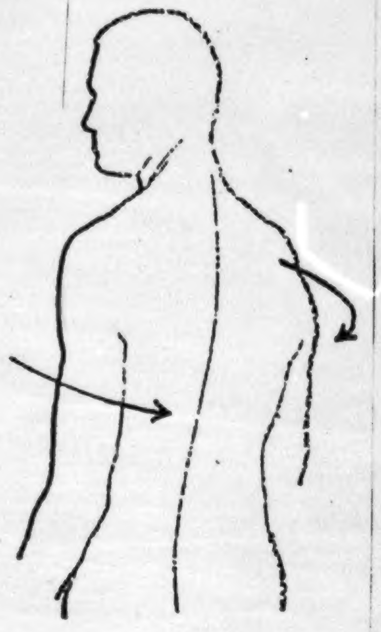
Figure 5. Types of freely movable joints

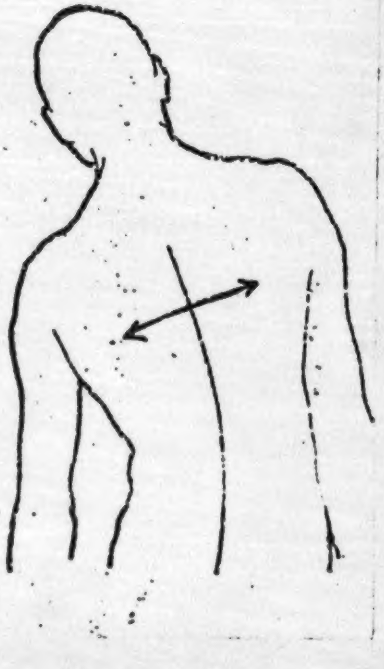
1. Gliding joint
2. Hinge joint
3. Pivot joint
4. Condyloid joint
5. Saddle joint
6. Ball & socket joint

7. The ulna is on the medinal side of the forearm?
8. Kyphesis is backward curve?
9. Lardoisis is forward curve?



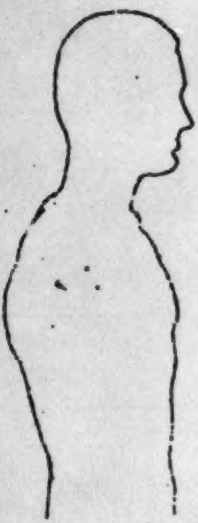




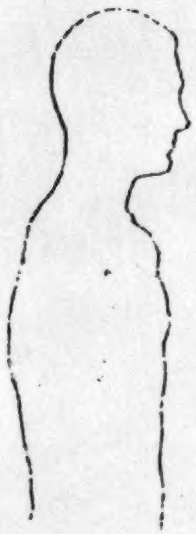


10. Flexion
11. Extension
12. Lateral flexion
13. Rotation

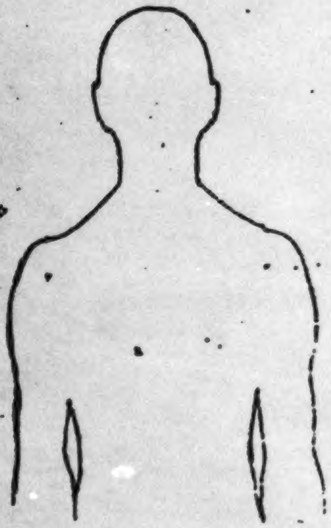
Trunk motion



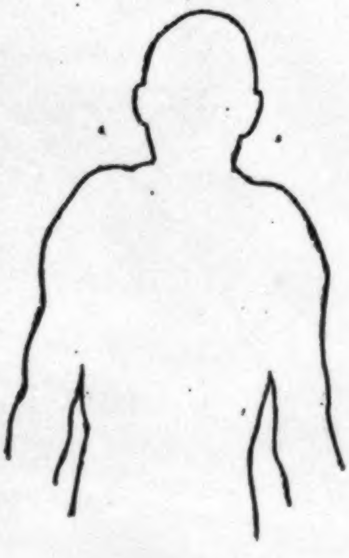
ADDUCTION



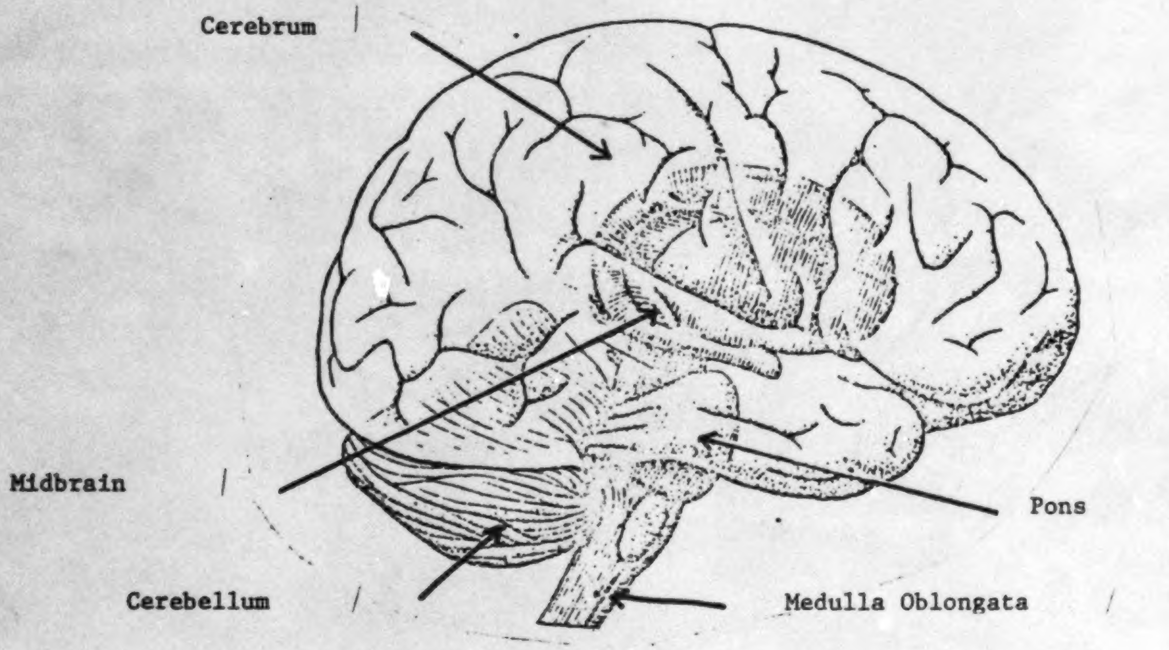
ABDUCTION

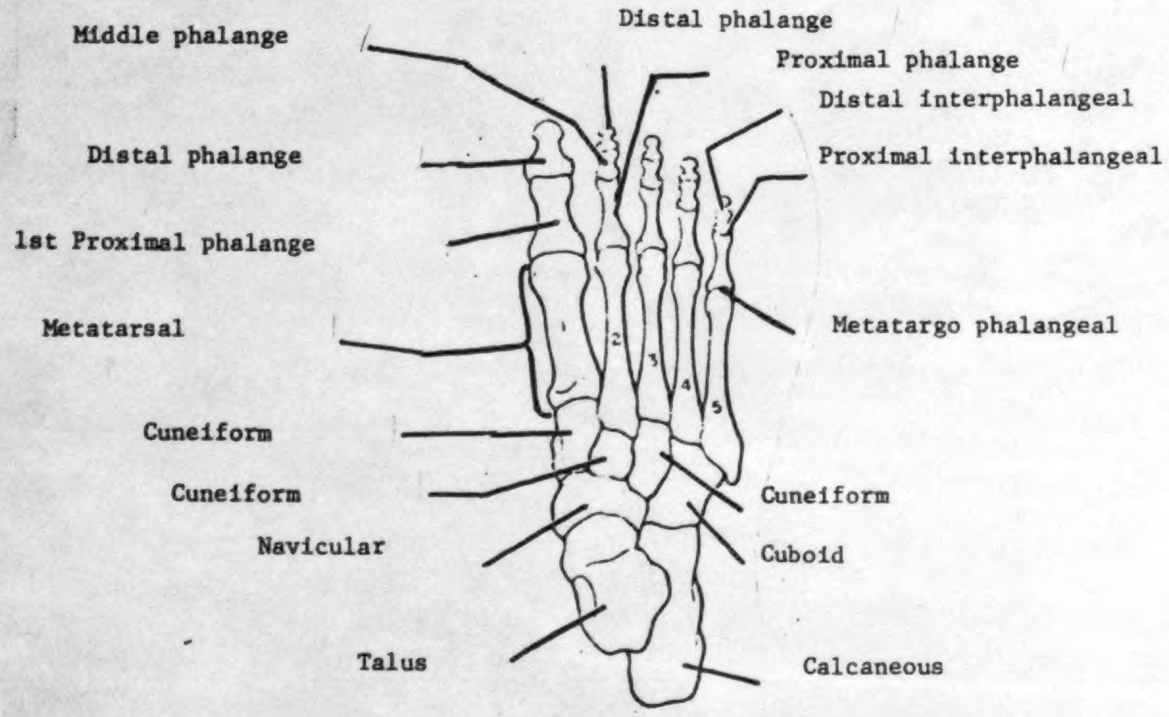


DEPRESSION



ELEVATION


Cerebrum
Midbrain
Pons
Cerebellum
Medulla Oblongata


Middle phalange
Distal phalange
Proximal phalange
Distal interphalangeal
Distal phalange
Proximal interphalangeal
1st Proximal phalange
Metatarsal
Metatargo phalangeal
1
2
3
4
5
Cuneiform
Cuneiform
Cuneiform
Navicular
Cuboid
Talus
Calcaneous